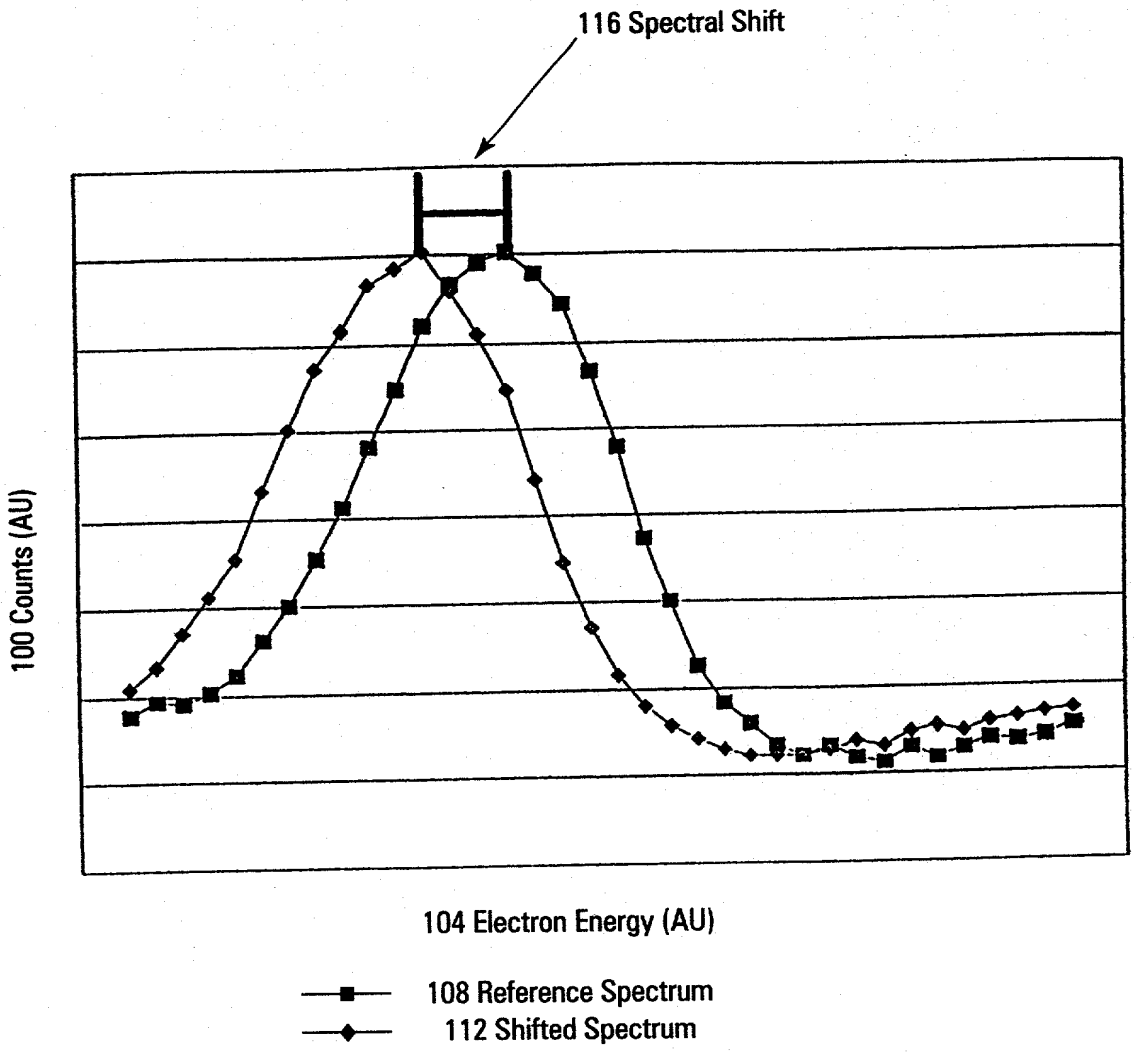


Fig. 1
(Prior Art)

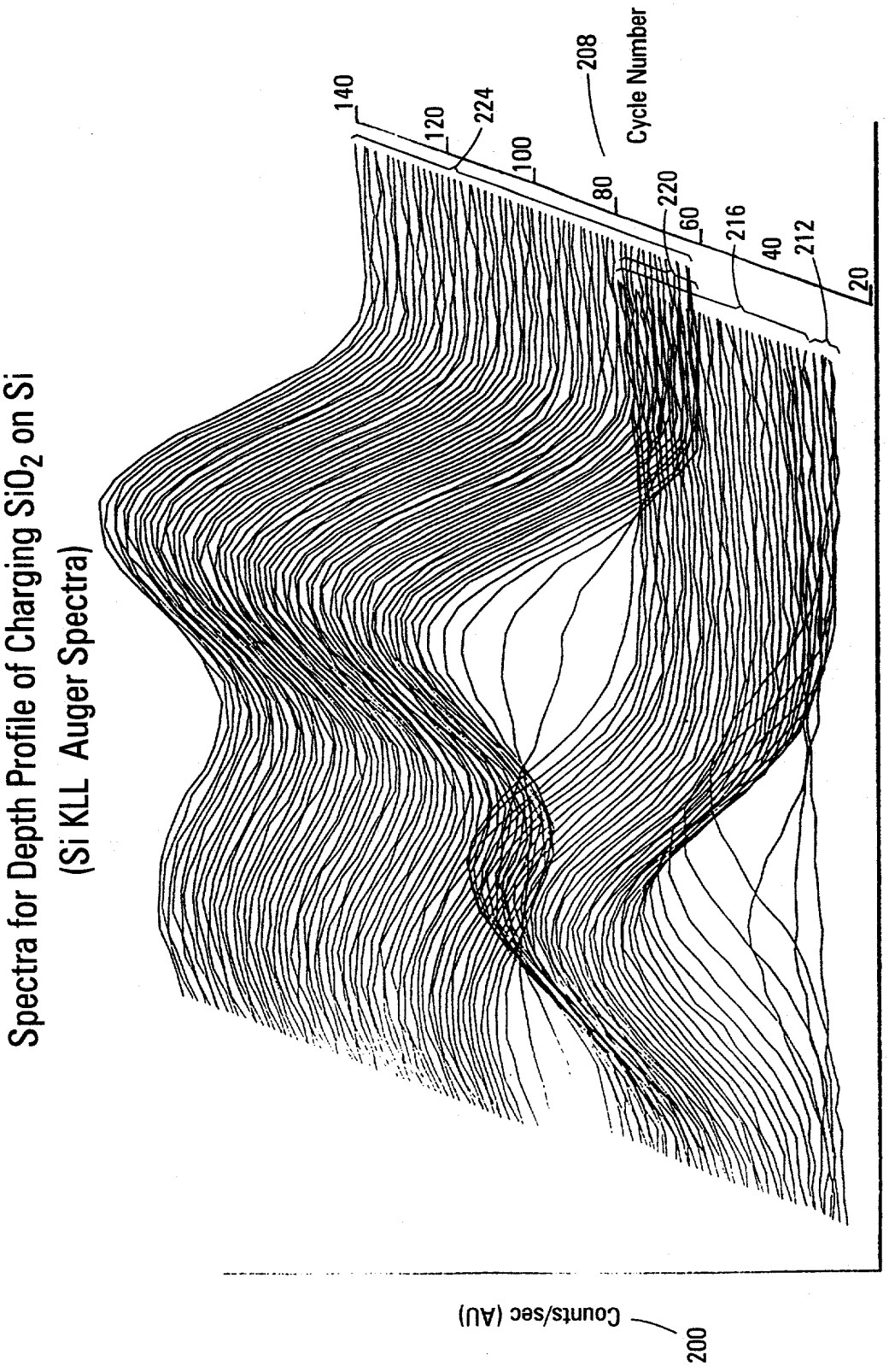
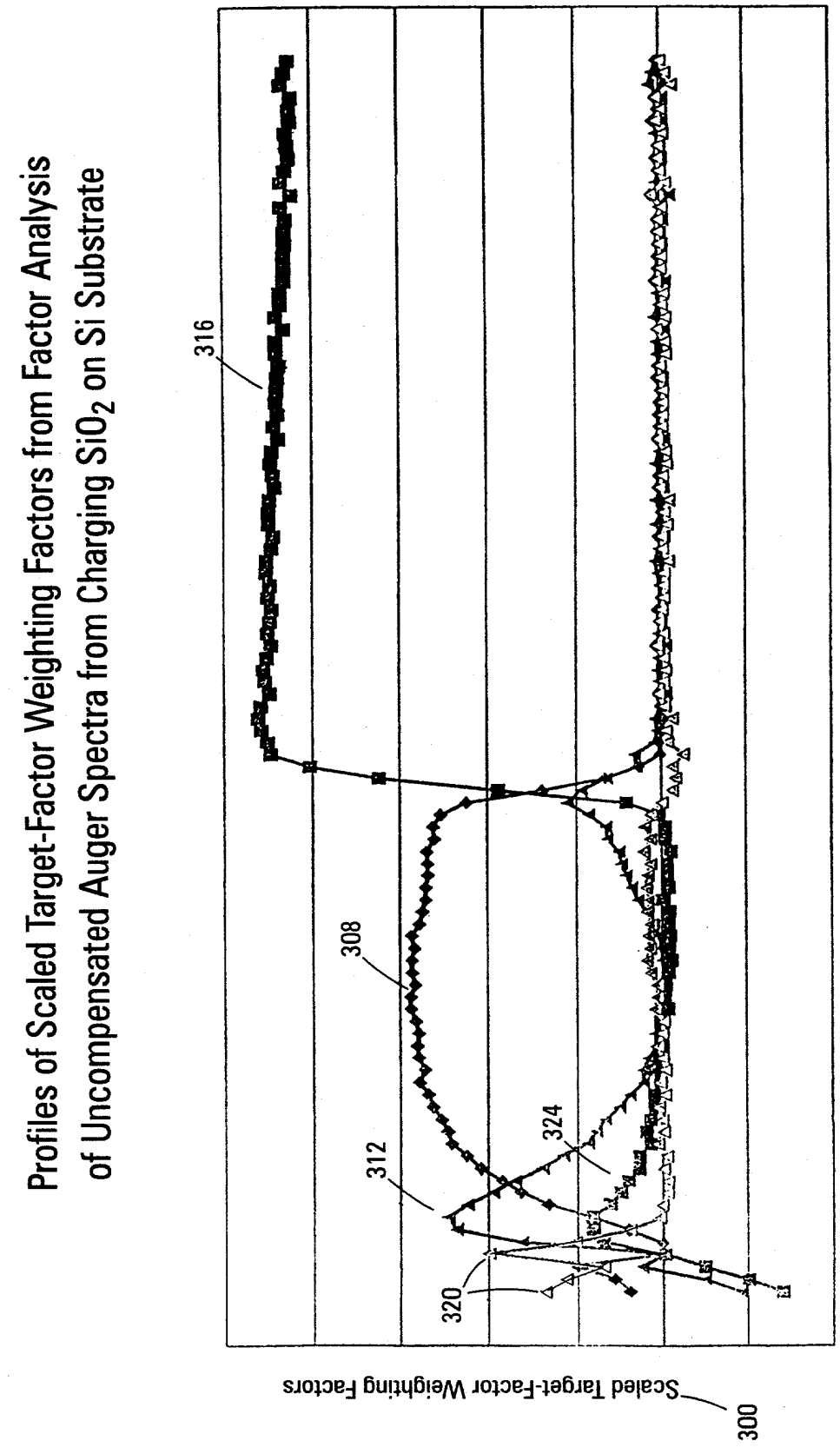


Fig. 2
(Prior Art)



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(Prior Art)

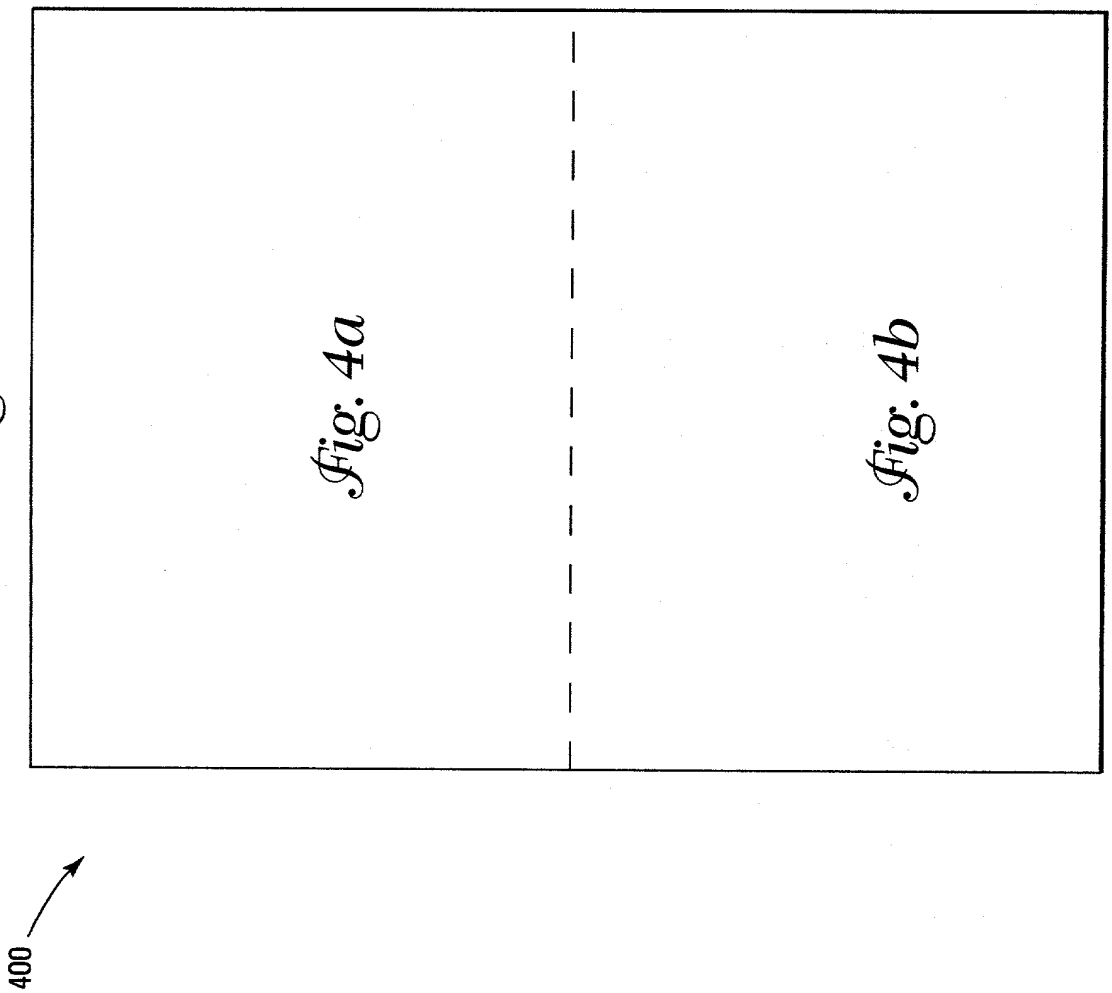
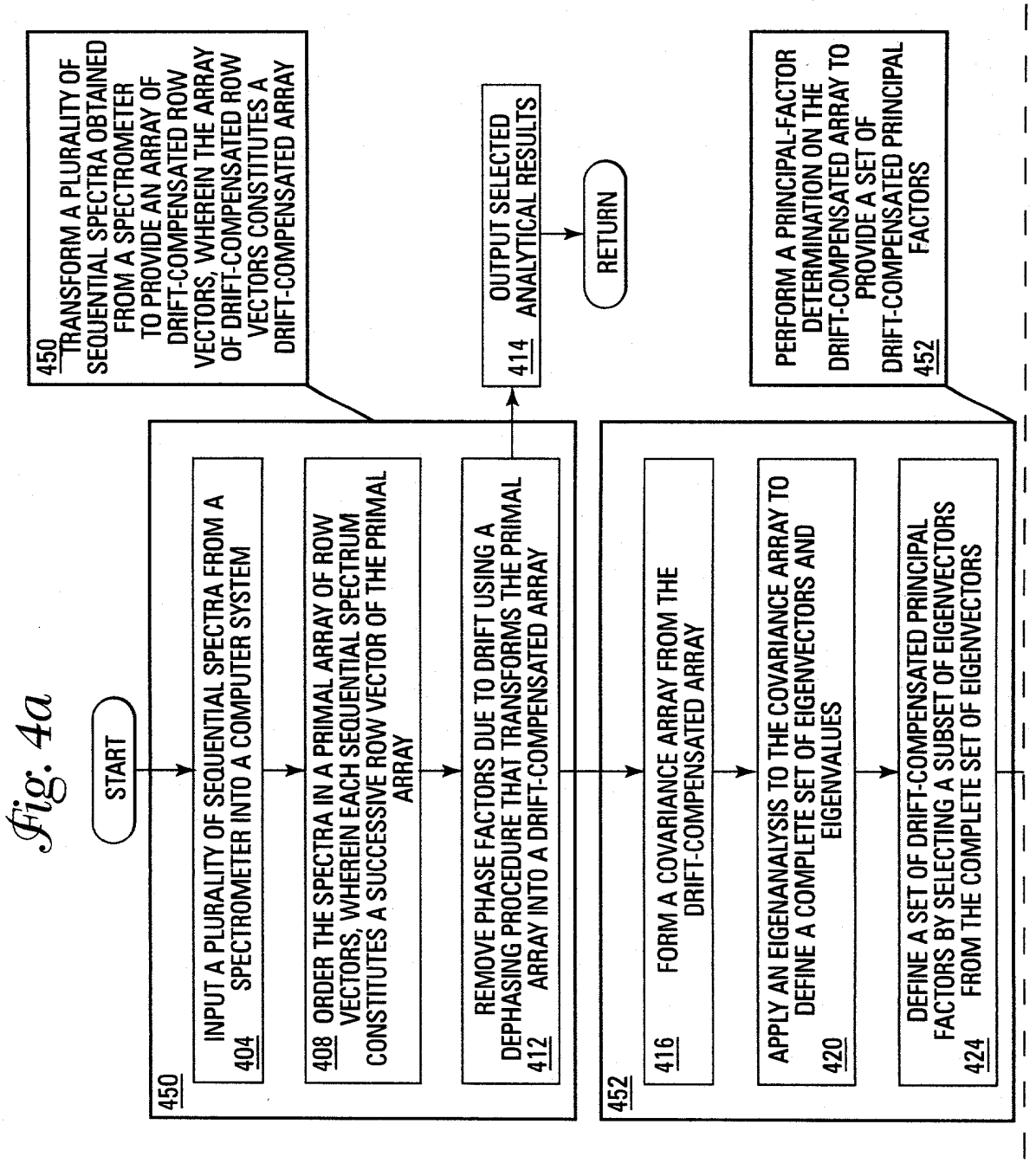


Fig. 4
Fig. 4a
Fig. 4b
400


START
450
INPUT A PLURALITY OF SEQUENTIAL SPECTRA FROM A SPECTROMETER INTO A COMPUTER SYSTEM 404
ORDER THE SPECTRA IN A PRIMAL ARRAY OF ROW VECTORS, WHEREIN EACH SEQUENTIAL SPECTRUM CONSTITUTES A SUCCESSIVE ROW VECTOR OF THE PRIMAL ARRAY 408
REMOVE PHASE FACTORS DUE TO DRIFT USING A DEPHASING PROCEDURE THAT TRANSFORMS THE PRIMAL ARRAY INTO A DRIFT-COMPENSATED ARRAY 412
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OUTPUT SELECTED ANALYTICAL RESULTS 414
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452
FORM A COVARIANCE ARRAY FROM THE DRIFT-COMPENSATED ARRAY 416
APPLY AN EIGENANALYSIS TO THE COVARIANCE ARRAY TO DEFINE A COMPLETE SET OF EIGENVECTORS AND EIGENVALUES 420
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PERFORM A PRINCIPAL-FACTOR DETERMINATION ON THE DRIFT-COMPENSATED ARRAY TO PROVIDE A SET OF DRIFT-COMPENSATED PRINCIPAL FACTORS 452

Fig. 4a

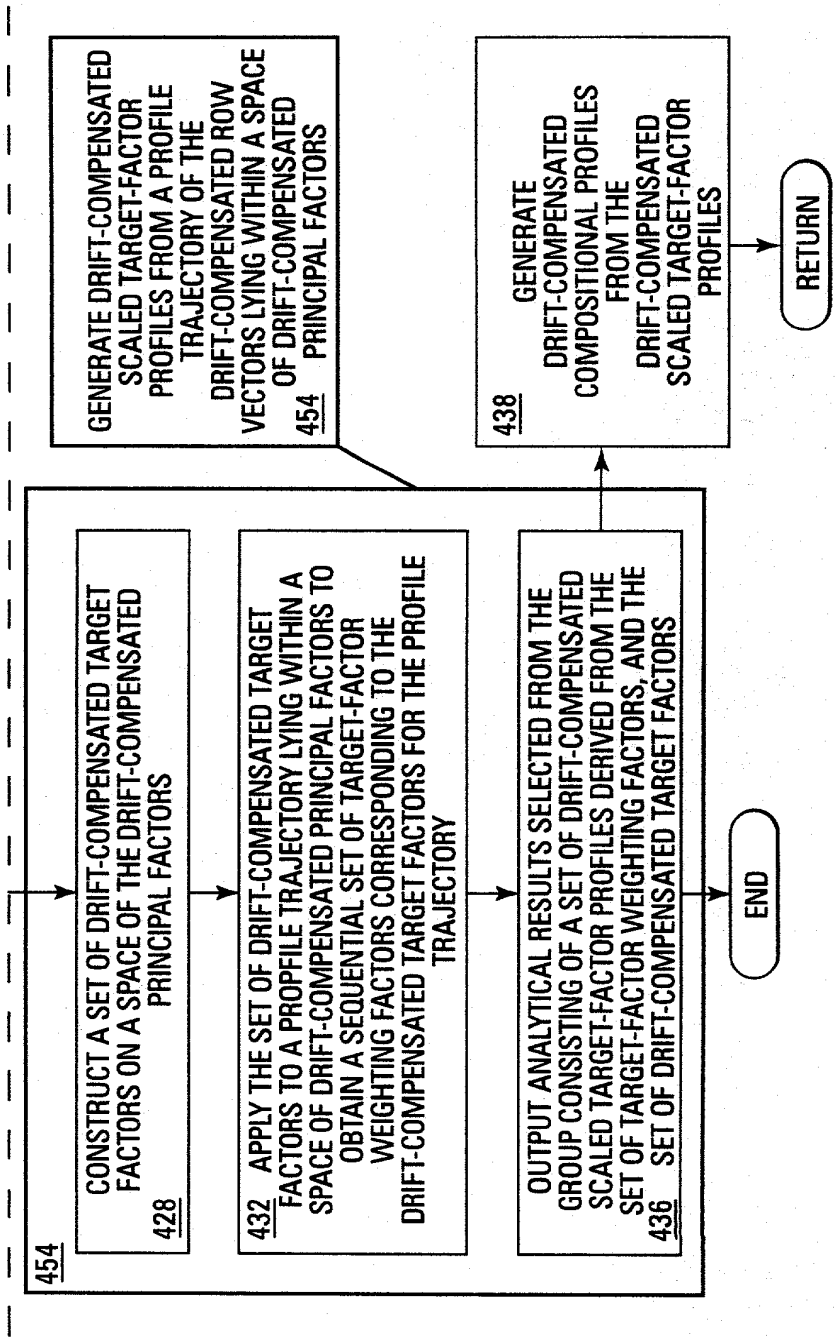

454
CONSTRUCT A SET OF DRIFT-COMPENSATED TARGET FACTORS ON A SPACE OF THE DRIFT-COMPENSATED PRINCIPAL FACTORS
428
APPLY THE SET OF DRIFT-COMPENSATED TARGET FACTORS TO A PROPFILE TRAJECTORY LYING WITHIN A SPACE OF DRIFT-COMPENSATED PRINCIPAL FACTORS TO OBTAIN A SEQUENTIAL SET OF TARGET-FACTOR WEIGHTING FACTORS CORRESPONDING TO THE DRIFT-COMPENSATED TARGET FACTORS FOR THE PROFILE TRAJECTORY
432
OUTPUT ANALYTICAL RESULTS SELECTED FROM THE GROUP CONSISTING OF A SET OF DRIFT-COMPENSATED SCALED TARGET-FACTOR PROFILES DERIVED FROM THE SET OF TARGET-FACTOR WEIGHTING FACTORS, AND THE SET OF DRIFT-COMPENSATED TARGET FACTORS
436
END
GENERATE DRIFT-COMPENSATED SCALED TARGET-FACTOR PROFILES FROM A PROFILE TRAJECTORY OF THE DRIFT-COMPENSATED ROW VECTORS LYING WITHIN A SPACE OF DRIFT-COMPENSATED PRINCIPAL FACTORS
454
GENERATE DRIFT-COMPENSATED COMPOSITIONAL PROFILES FROM THE DRIFT-COMPENSATED SCALED TARGET-FACTOR PROFILES
438
RETURN

Fig. 4b

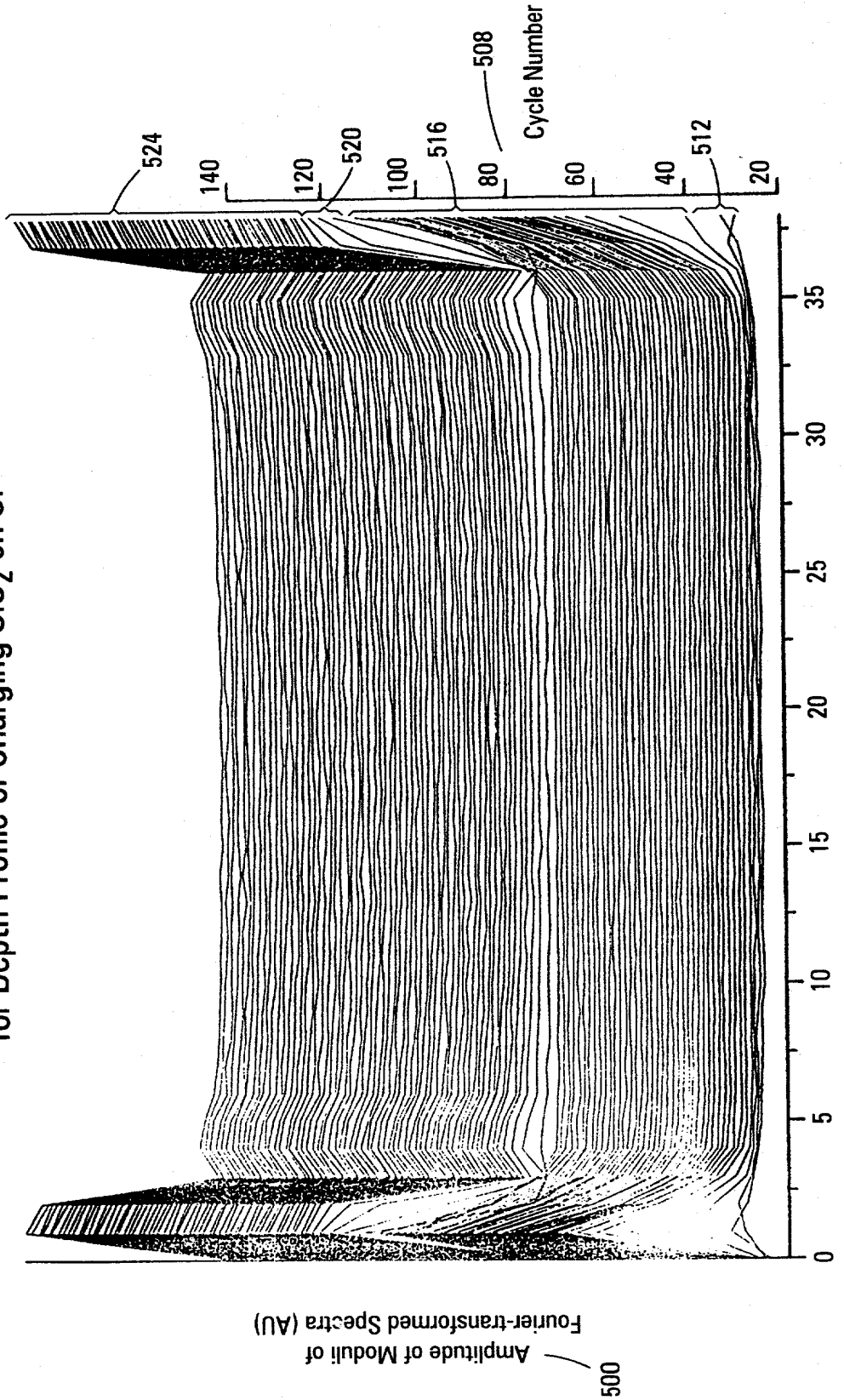

Moduli of Fourier-transformed Spectra
for Depth Profile of Charging SiO_2 on Si
Amplitude of Moduli of
Fourier-transformed Spectra (AU)
500
Cycle Number
524
140
120
520
100
516
80
508
60
40
512
20
0
5
10
15
20
25
30
35
Frequency (AU)
504

Fig. 5

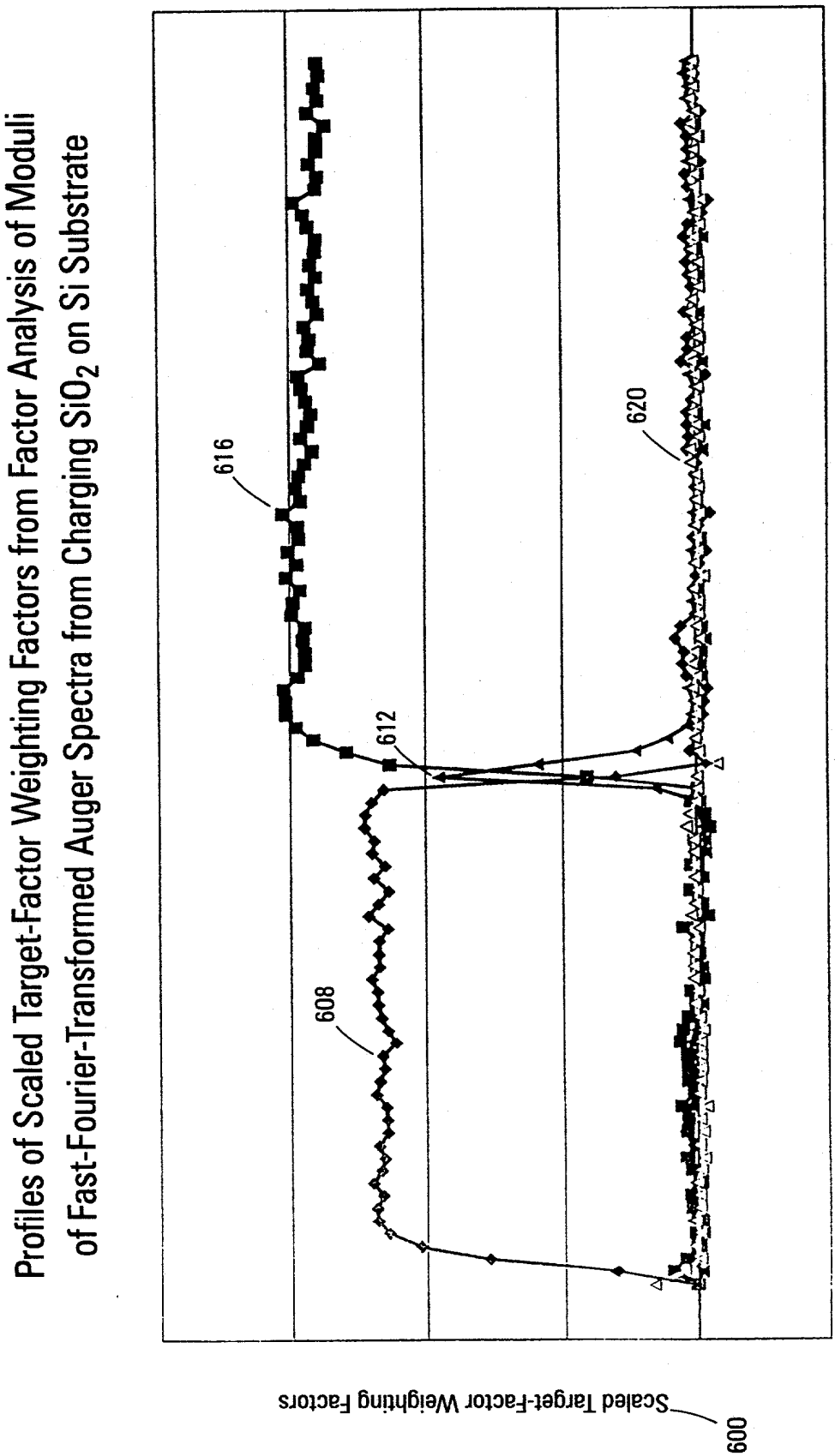

Profiles of Scaled Target-Factor Weighting Factors from Factor Analysis of Moduli of Fast-Fourier-Transformed Auger Spectra from Charging SiO_2 on Si Substrate
Scaled Target-Factor Weighting Factors
600
Cycle Number
604
616
612
608
620
Si(reduced)
$Si(SiO_2)$
Si(SiOx)
Residue

Fig. 6

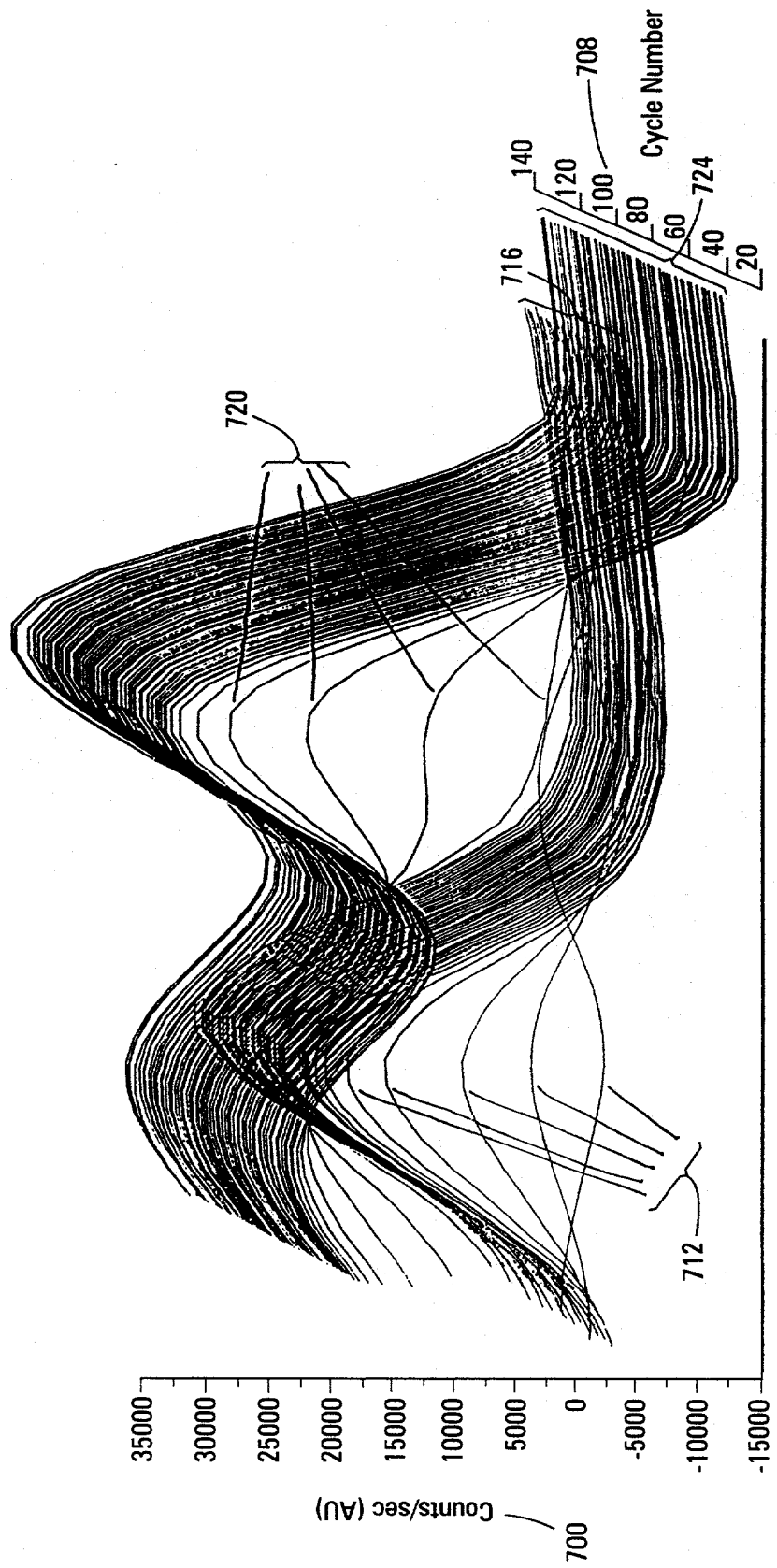

Drift-Compensated Spectra Synthesized
from Selected Reference Spectra Fit to Primal Spectra
for Depth Profile of Charging SiO_2 on Si
Counts/sec (AU)
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
Kinetic Energy, (eV)
Cycle Number
140
120
100
80
60
40
20
700
704
708
712
716
720
724

Fig. 7

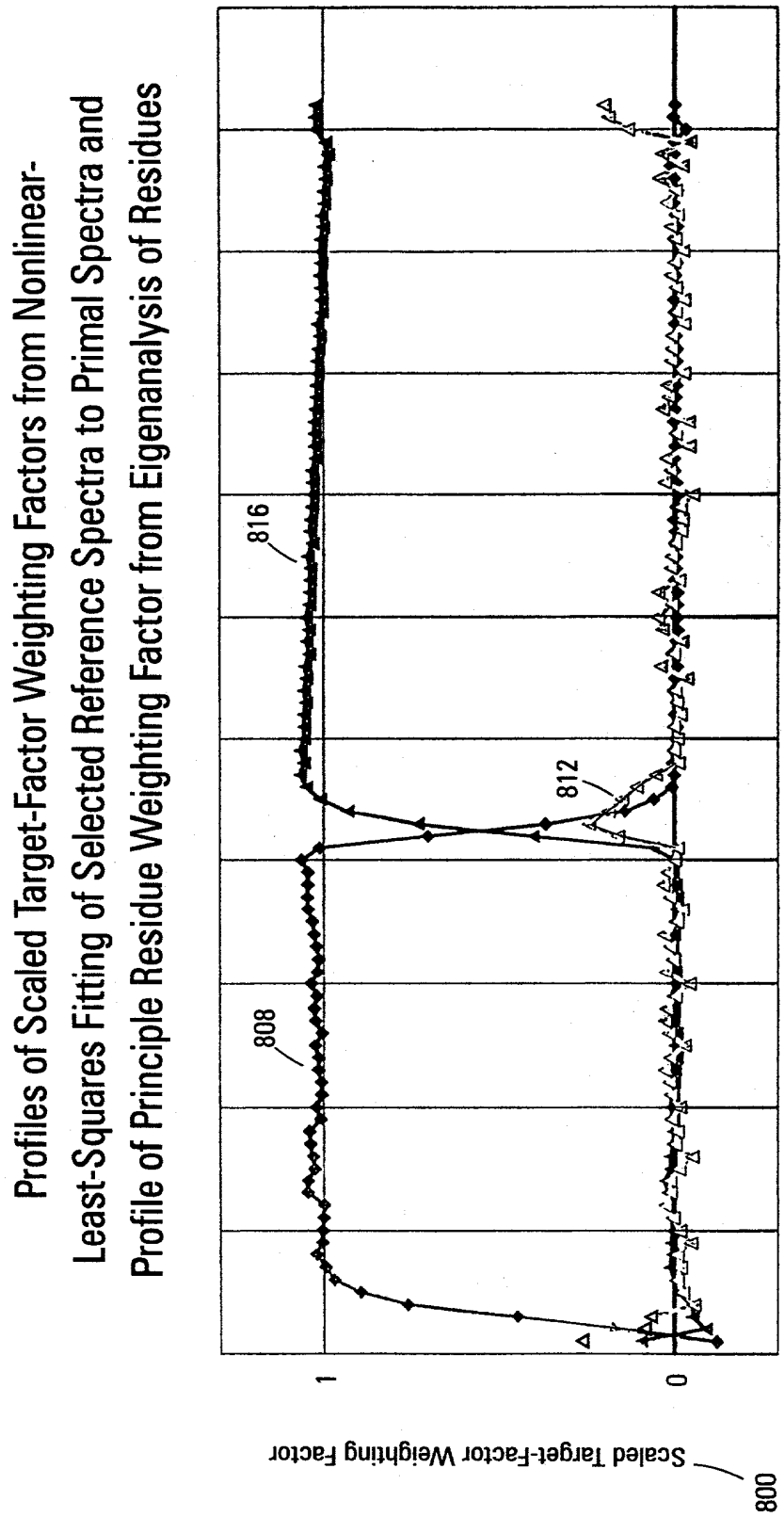

Profiles of Scaled Target-Factor Weighting Factors from Nonlinear-Least-Squares Fitting of Selected Reference Spectra to Primal Spectra and Profile of Principle Residue Weighting Factor from Eigenanalysis of Residues
800
Scaled Target-Factor Weighting Factor
1
0
808
812
816
Cycle Number
804
Si(SiO2)
Si(reduced)
Principle-Residue Weighting Factor

Fig. 8

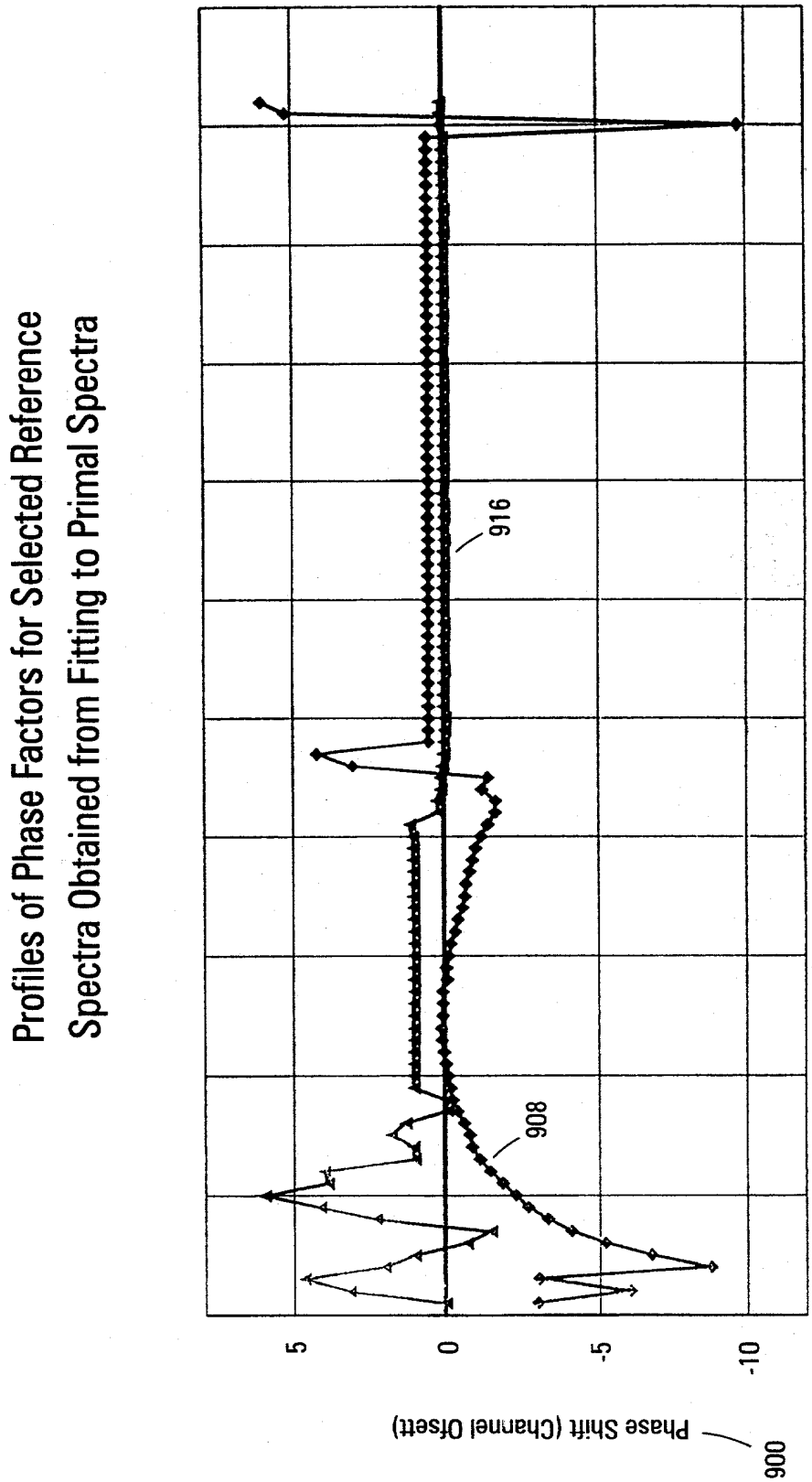

Profiles of Phase Factors for Selected Reference Spectra Obtained from Fitting to Primal Spectra
900
Phase Shift (Channel Offset)
5
0
-5
-10
916
908
904
Cycle Number
Si(SiO2)
Si(reduced)

Fig. 9

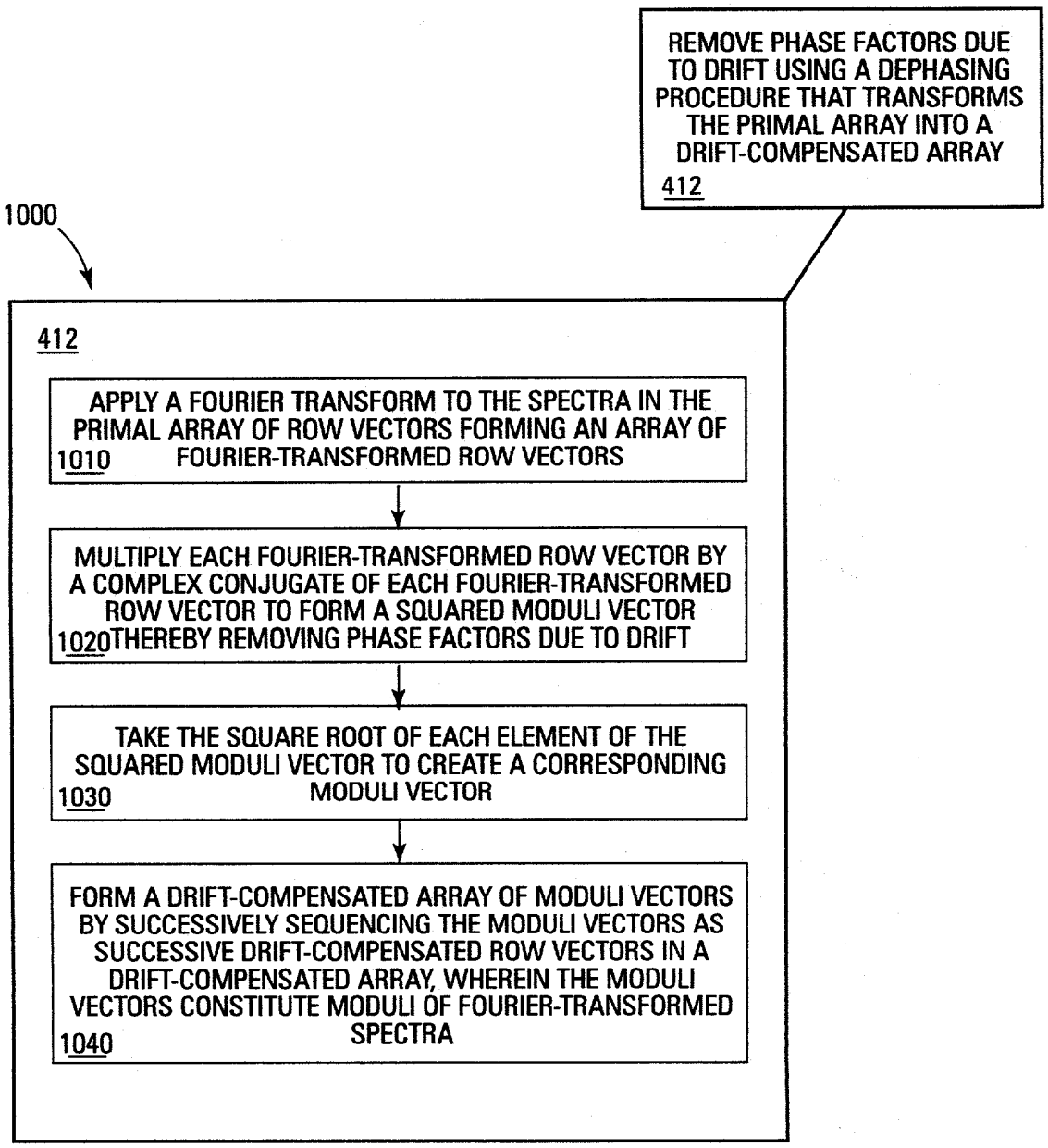

REMOVE PHASE FACTORS DUE TO DRIFT USING A DEPHASING PROCEDURE THAT TRANSFORMS THE PRIMAL ARRAY INTO A DRIFT-COMPENSATED ARRAY
412
1000
412
APPLY A FOURIER TRANSFORM TO THE SPECTRA IN THE PRIMAL ARRAY OF ROW VECTORS FORMING AN ARRAY OF
1010 FOURIER-TRANSFORMED ROW VECTORS
MULTIPLY EACH FOURIER-TRANSFORMED ROW VECTOR BY A COMPLEX CONJUGATE OF EACH FOURIER-TRANSFORMED ROW VECTOR TO FORM A SQUARED MODULI VECTOR
1020THEREBY REMOVING PHASE FACTORS DUE TO DRIFT
TAKE THE SQUARE ROOT OF EACH ELEMENT OF THE SQUARED MODULI VECTOR TO CREATE A CORRESPONDING
1030 MODULI VECTOR
FORM A DRIFT-COMPENSATED ARRAY OF MODULI VECTORS BY SUCCESSIVELY SEQUENCING THE MODULI VECTORS AS SUCCESSIVE DRIFT-COMPENSATED ROW VECTORS IN A DRIFT-COMPENSATED ARRAY, WHEREIN THE MODULI VECTORS CONSTITUTE MODULI OF FOURIER-TRANSFORMED
1040 SPECTRA

Fig. 10

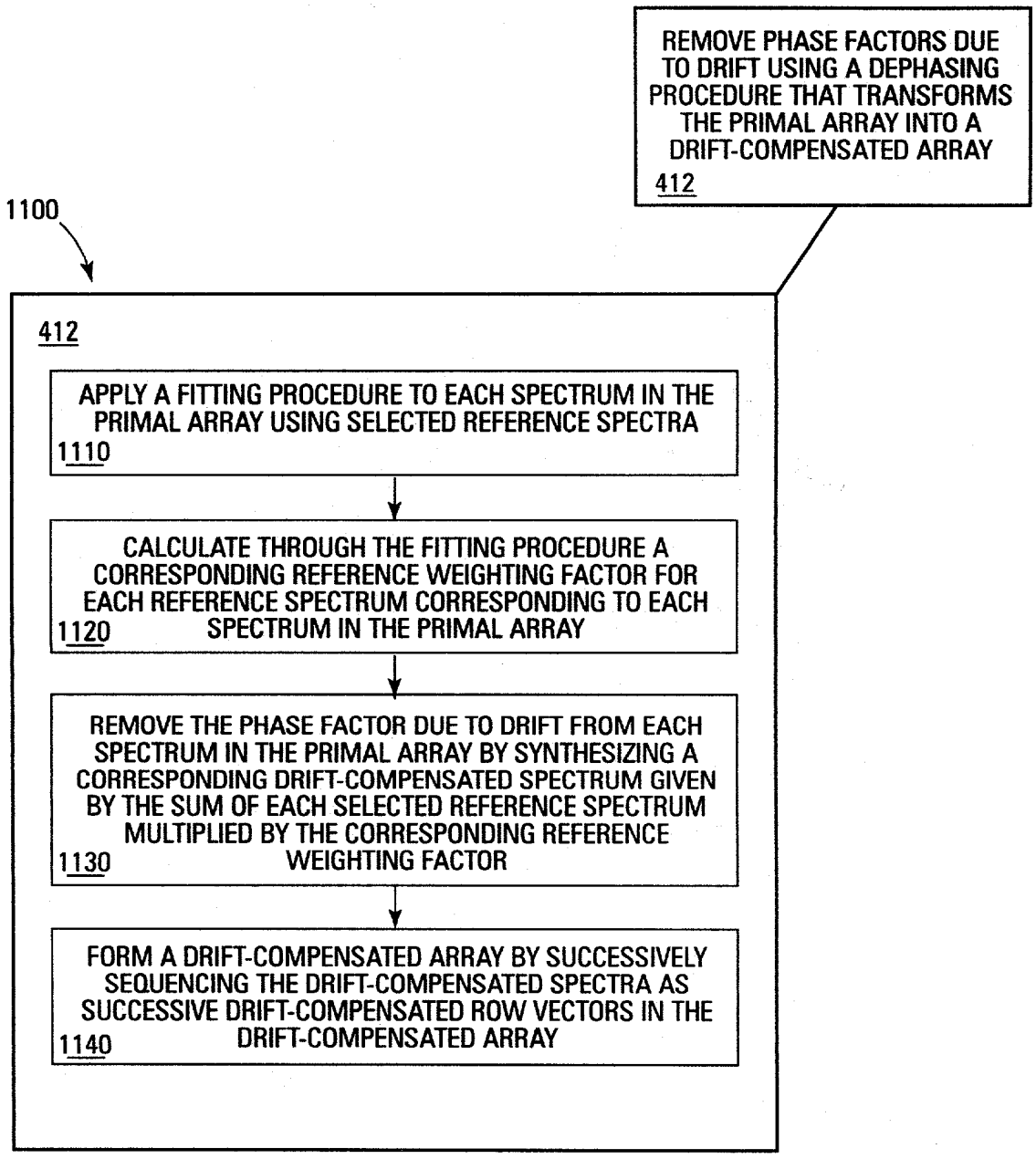

REMOVE PHASE FACTORS DUE TO DRIFT USING A DEPHASING PROCEDURE THAT TRANSFORMS THE PRIMAL ARRAY INTO A DRIFT-COMPENSATED ARRAY
412
1100
412
APPLY A FITTING PROCEDURE TO EACH SPECTRUM IN THE PRIMAL ARRAY USING SELECTED REFERENCE SPECTRA
1110
CALCULATE THROUGH THE FITTING PROCEDURE A CORRESPONDING REFERENCE WEIGHTING FACTOR FOR EACH REFERENCE SPECTRUM CORRESPONDING TO EACH SPECTRUM IN THE PRIMAL ARRAY
1120
REMOVE THE PHASE FACTOR DUE TO DRIFT FROM EACH SPECTRUM IN THE PRIMAL ARRAY BY SYNTHESIZING A CORRESPONDING DRIFT-COMPENSATED SPECTRUM GIVEN BY THE SUM OF EACH SELECTED REFERENCE SPECTRUM MULTIPLIED BY THE CORRESPONDING REFERENCE WEIGHTING FACTOR
1130
FORM A DRIFT-COMPENSATED ARRAY BY SUCCESSIVELY SEQUENCING THE DRIFT-COMPENSATED SPECTRA AS SUCCESSIVE DRIFT-COMPENSATED ROW VECTORS IN THE DRIFT-COMPENSATED ARRAY
1140

Fig. 11

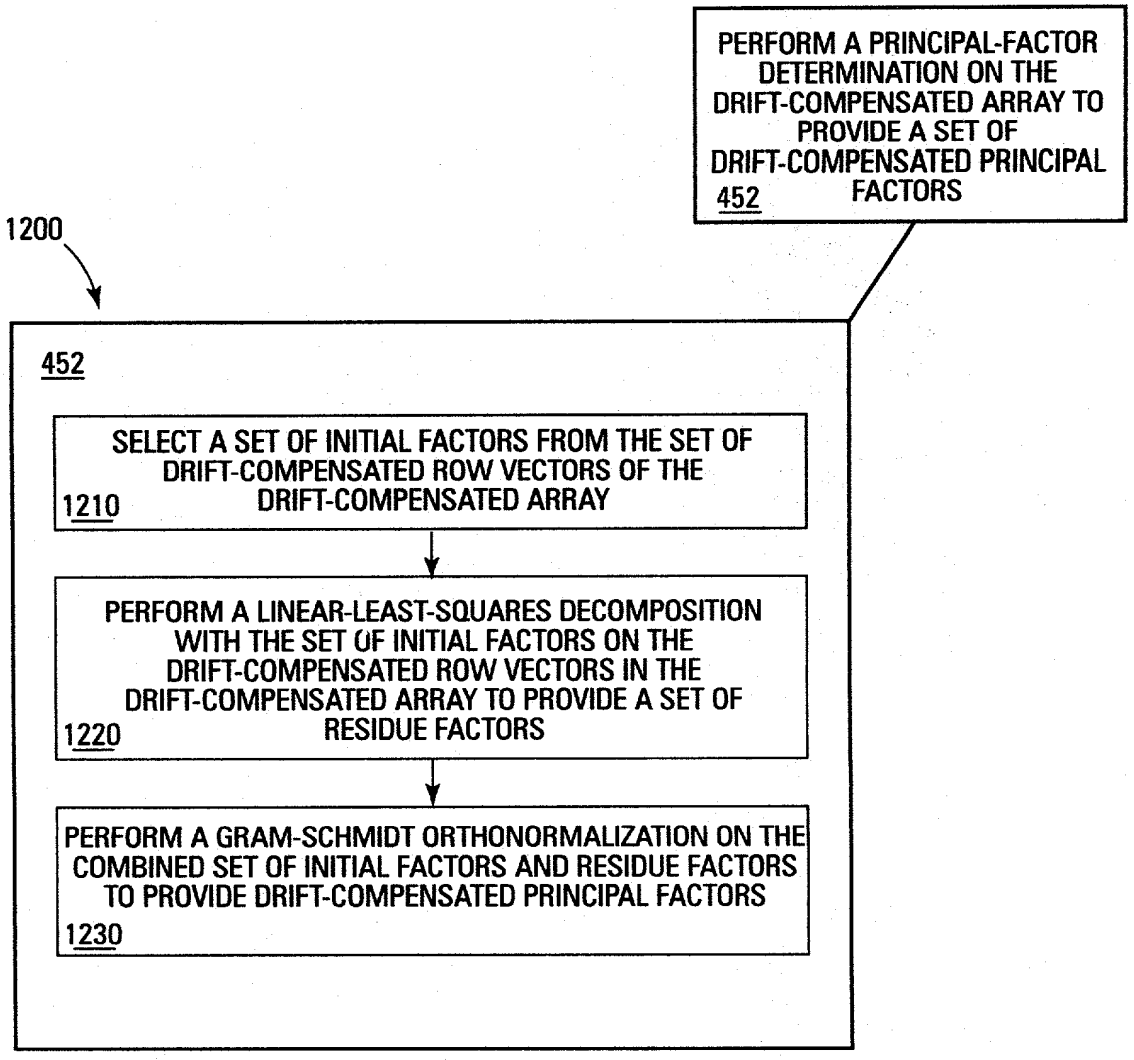

PERFORM A PRINCIPAL-FACTOR DETERMINATION ON THE DRIFT-COMPENSATED ARRAY TO PROVIDE A SET OF DRIFT-COMPENSATED PRINCIPAL FACTORS
452
1200
452
SELECT A SET OF INITIAL FACTORS FROM THE SET OF DRIFT-COMPENSATED ROW VECTORS OF THE DRIFT-COMPENSATED ARRAY
1210
PERFORM A LINEAR-LEAST-SQUARES DECOMPOSITION WITH THE SET OF INITIAL FACTORS ON THE DRIFT-COMPENSATED ROW VECTORS IN THE DRIFT-COMPENSATED ARRAY TO PROVIDE A SET OF RESIDUE FACTORS
1220
PERFORM A GRAM-SCHMIDT ORTHONORMALIZATION ON THE COMBINED SET OF INITIAL FACTORS AND RESIDUE FACTORS TO PROVIDE DRIFT-COMPENSATED PRINCIPAL FACTORS
1230

Fig. 12

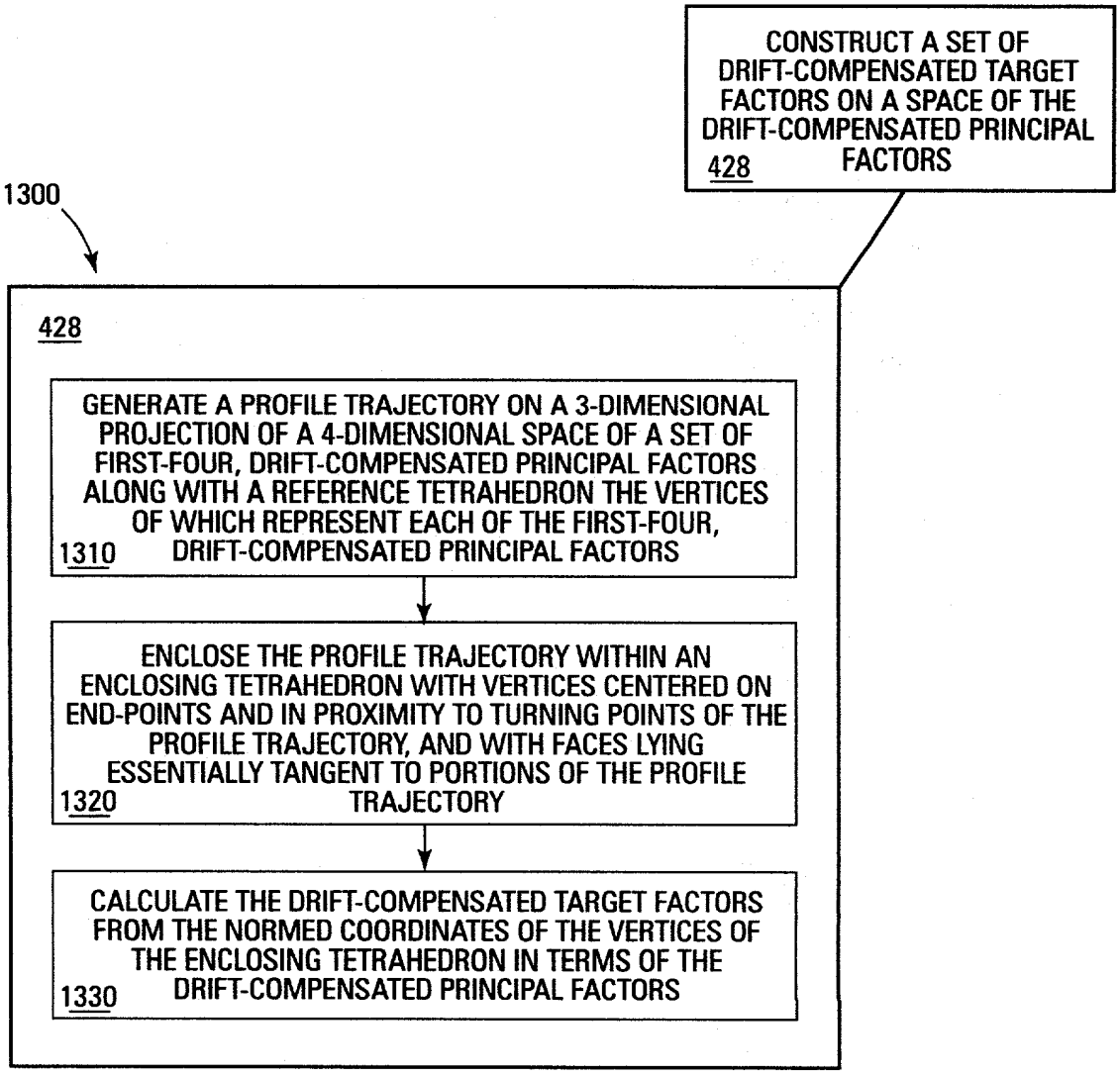

CONSTRUCT A SET OF DRIFT-COMPENSATED TARGET FACTORS ON A SPACE OF THE DRIFT-COMPENSATED PRINCIPAL FACTORS
428
1300
428
GENERATE A PROFILE TRAJECTORY ON A 3-DIMENSIONAL PROJECTION OF A 4-DIMENSIONAL SPACE OF A SET OF FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS ALONG WITH A REFERENCE TETRAHEDRON THE VERTICES OF WHICH REPRESENT EACH OF THE FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS
1310
ENCLOSE THE PROFILE TRAJECTORY WITHIN AN ENCLOSING TETRAHEDRON WITH VERTICES CENTERED ON END-POINTS AND IN PROXIMITY TO TURNING POINTS OF THE PROFILE TRAJECTORY, AND WITH FACES LYING ESSENTIALLY TANGENT TO PORTIONS OF THE PROFILE TRAJECTORY
1320
CALCULATE THE DRIFT-COMPENSATED TARGET FACTORS FROM THE NORMED COORDINATES OF THE VERTICES OF THE ENCLOSING TETRAHEDRON IN TERMS OF THE DRIFT-COMPENSATED PRINCIPAL FACTORS
1330

Fig. 13

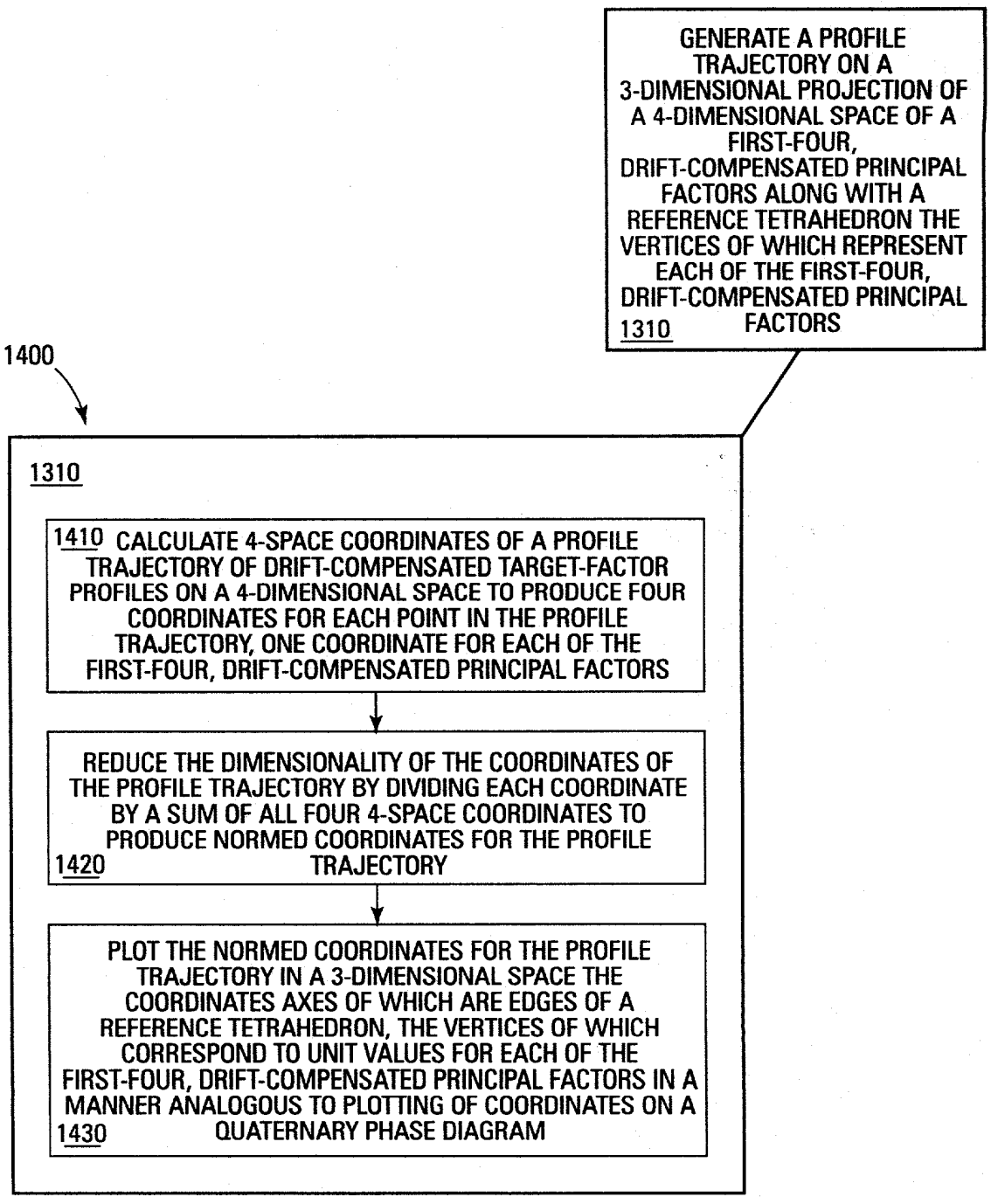

GENERATE A PROFILE TRAJECTORY ON A 3-DIMENSIONAL PROJECTION OF A 4-DIMENSIONAL SPACE OF A FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS ALONG WITH A REFERENCE TETRAHEDRON THE VERTICES OF WHICH REPRESENT EACH OF THE FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS
1310
1400
1310
1410 CALCULATE 4-SPACE COORDINATES OF A PROFILE TRAJECTORY OF DRIFT-COMPENSATED TARGET-FACTOR PROFILES ON A 4-DIMENSIONAL SPACE TO PRODUCE FOUR COORDINATES FOR EACH POINT IN THE PROFILE TRAJECTORY, ONE COORDINATE FOR EACH OF THE FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS
REDUCE THE DIMENSIONALITY OF THE COORDINATES OF THE PROFILE TRAJECTORY BY DIVIDING EACH COORDINATE BY A SUM OF ALL FOUR 4-SPACE COORDINATES TO PRODUCE NORMED COORDINATES FOR THE PROFILE TRAJECTORY
1420
PLOT THE NORMED COORDINATES FOR THE PROFILE TRAJECTORY IN A 3-DIMENSIONAL SPACE THE COORDINATES AXES OF WHICH ARE EDGES OF A REFERENCE TETRAHEDRON, THE VERTICES OF WHICH CORRESPOND TO UNIT VALUES FOR EACH OF THE FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS IN A MANNER ANALOGOUS TO PLOTTING OF COORDINATES ON A QUATERNARY PHASE DIAGRAM
1430

Fig. 14

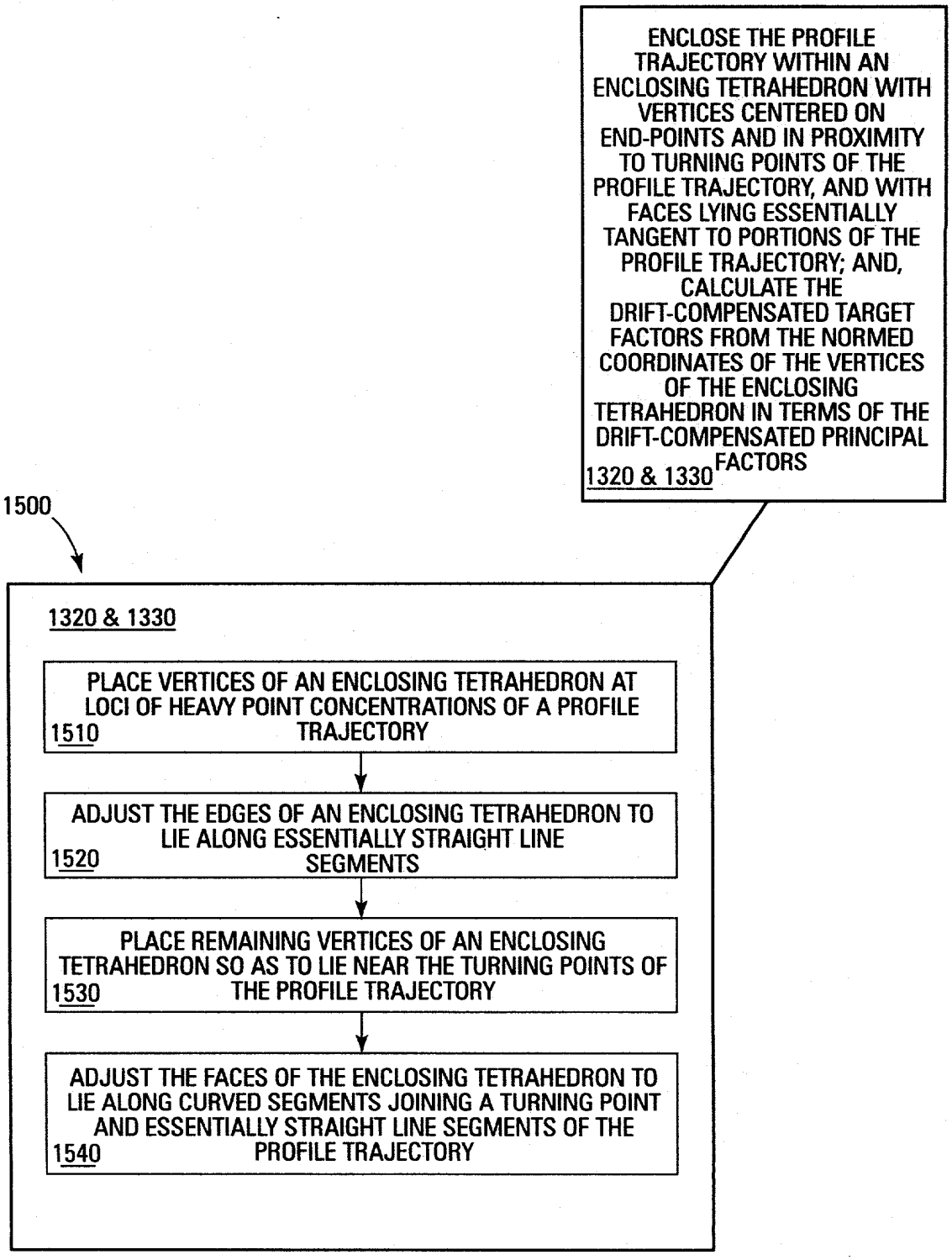

ENCLOSE THE PROFILE TRAJECTORY WITHIN AN ENCLOSING TETRAHEDRON WITH VERTICES CENTERED ON END-POINTS AND IN PROXIMITY TO TURNING POINTS OF THE PROFILE TRAJECTORY, AND WITH FACES LYING ESSENTIALLY TANGENT TO PORTIONS OF THE PROFILE TRAJECTORY; AND, CALCULATE THE DRIFT-COMPENSATED TARGET FACTORS FROM THE NORMED COORDINATES OF THE VERTICES OF THE ENCLOSING TETRAHEDRON IN TERMS OF THE DRIFT-COMPENSATED PRINCIPAL FACTORS
1320 & 1330
1500
1320 & 1330
PLACE VERTICES OF AN ENCLOSING TETRAHEDRON AT LOCI OF HEAVY POINT CONCENTRATIONS OF A PROFILE TRAJECTORY
1510
ADJUST THE EDGES OF AN ENCLOSING TETRAHEDRON TO LIE ALONG ESSENTIALLY STRAIGHT LINE SEGMENTS
1520
PLACE REMAINING VERTICES OF AN ENCLOSING TETRAHEDRON SO AS TO LIE NEAR THE TURNING POINTS OF THE PROFILE TRAJECTORY
1530
ADJUST THE FACES OF THE ENCLOSING TETRAHEDRON TO LIE ALONG CURVED SEGMENTS JOINING A TURNING POINT AND ESSENTIALLY STRAIGHT LINE SEGMENTS OF THE PROFILE TRAJECTORY
1540

Fig. 15

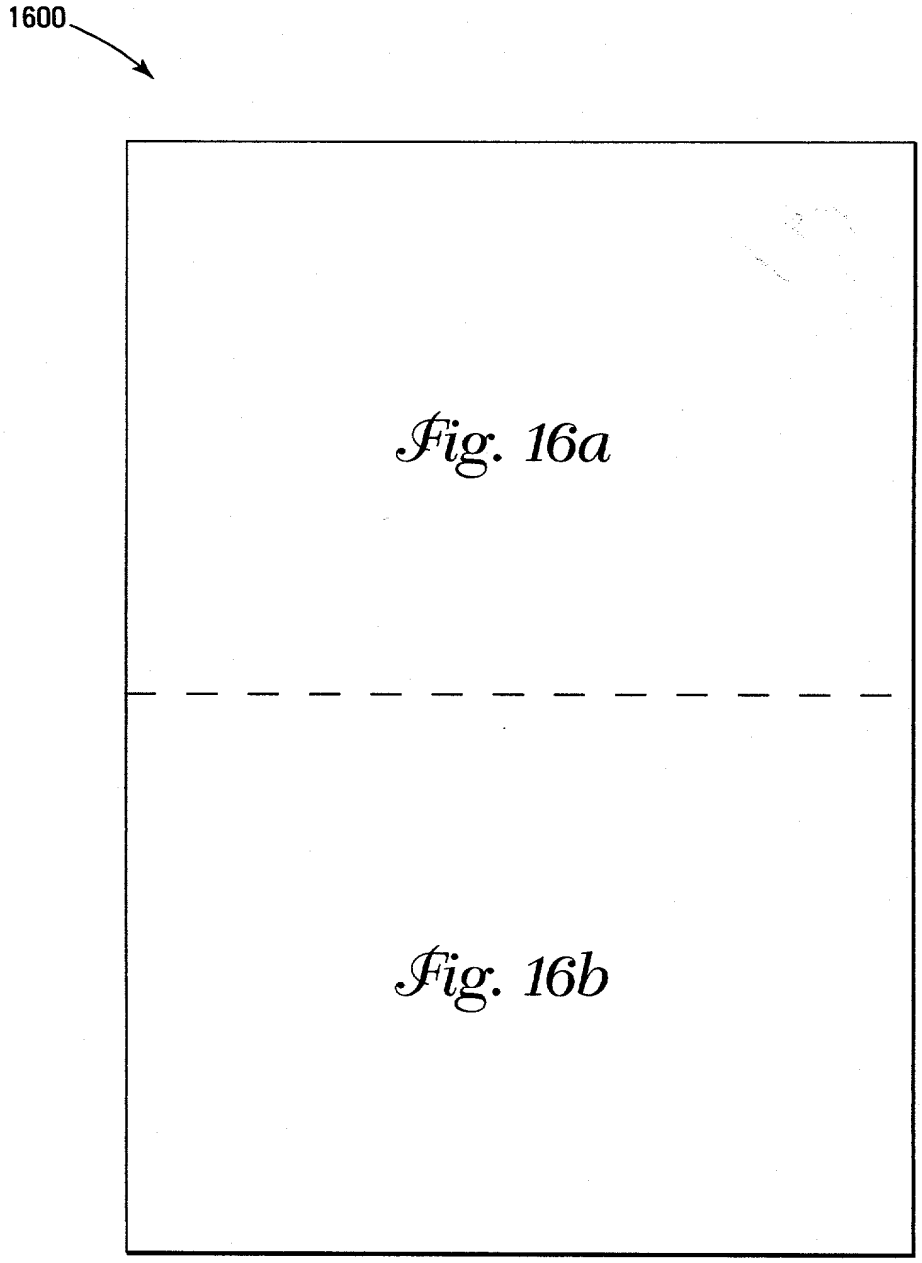
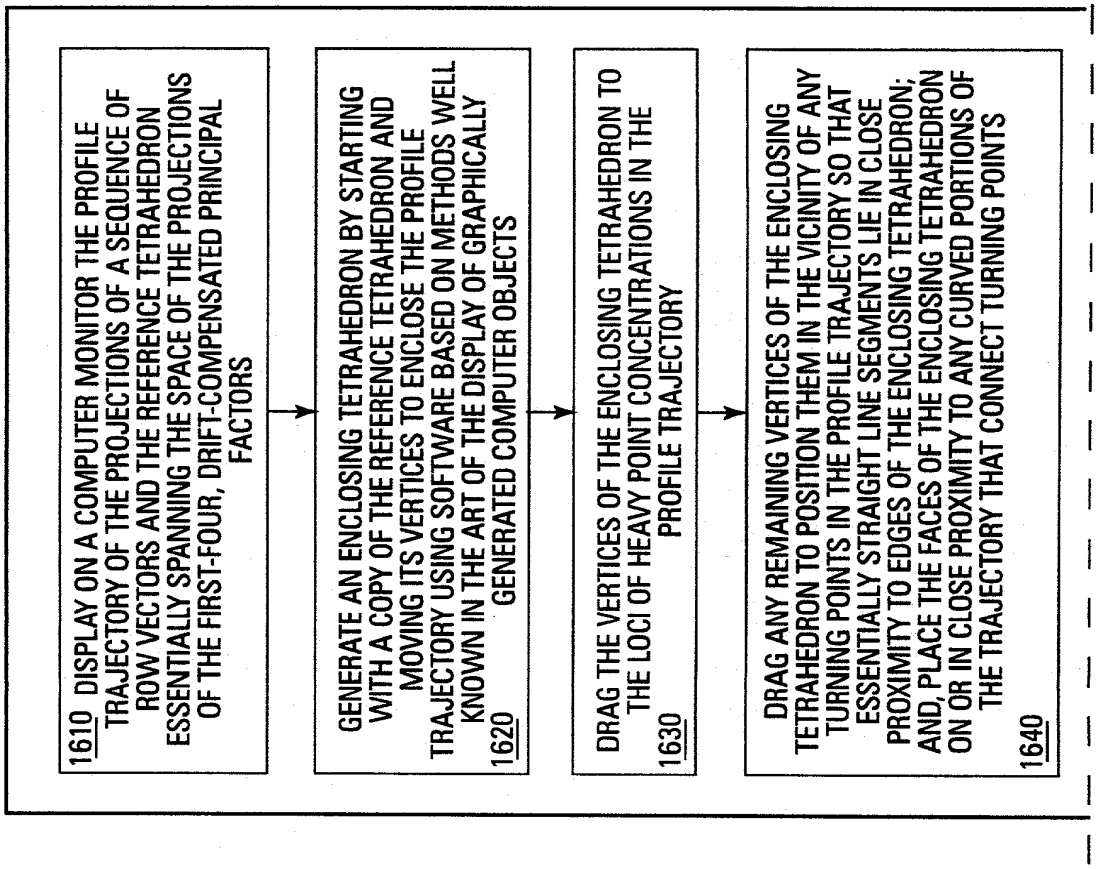


Fig. 16a

Fig. 16b

Fig. 16

Fig. 16a


1610 DISPLAY ON A COMPUTER MONITOR THE PROFILE TRAJECTORY OF THE PROJECTIONS OF A SEQUENCE OF ROW VECTORS AND THE REFERENCE TETRAHEDRON ESSENTIALLY SPANNING THE SPACE OF THE PROJECTIONS OF THE FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS
1620 GENERATE AN ENCLOSING TETRAHEDRON BY STARTING WITH A COPY OF THE REFERENCE TETRAHEDRON AND MOVING ITS VERTICES TO ENCLOSE THE PROFILE TRAJECTORY USING SOFTWARE BASED ON METHODS WELL KNOWN IN THE ART OF THE DISPLAY OF GRAPHICALLY GENERATED COMPUTER OBJECTS
1630 DRAG THE VERTICES OF THE ENCLOSING TETRAHEDRON TO THE LOCI OF HEAVY POINT CONCENTRATIONS IN THE PROFILE TRAJECTORY
1640 DRAG ANY REMAINING VERTICES OF THE ENCLOSING TETRAHEDRON TO POSITION THEM IN THE VICINITY OF ANY TURNING POINTS IN THE PROFILE TRAJECTORY SO THAT ESSENTIALLY STRAIGHT LINE SEGMENTS LIE IN CLOSE PROXIMITY TO EDGES OF THE ENCLOSING TETRAHEDRON; AND, PLACE THE FACES OF THE ENCLOSING TETRAHEDRON ON OR IN CLOSE PROXIMITY TO ANY CURVED PORTIONS OF THE TRAJECTORY THAT CONNECT TURNING POINTS

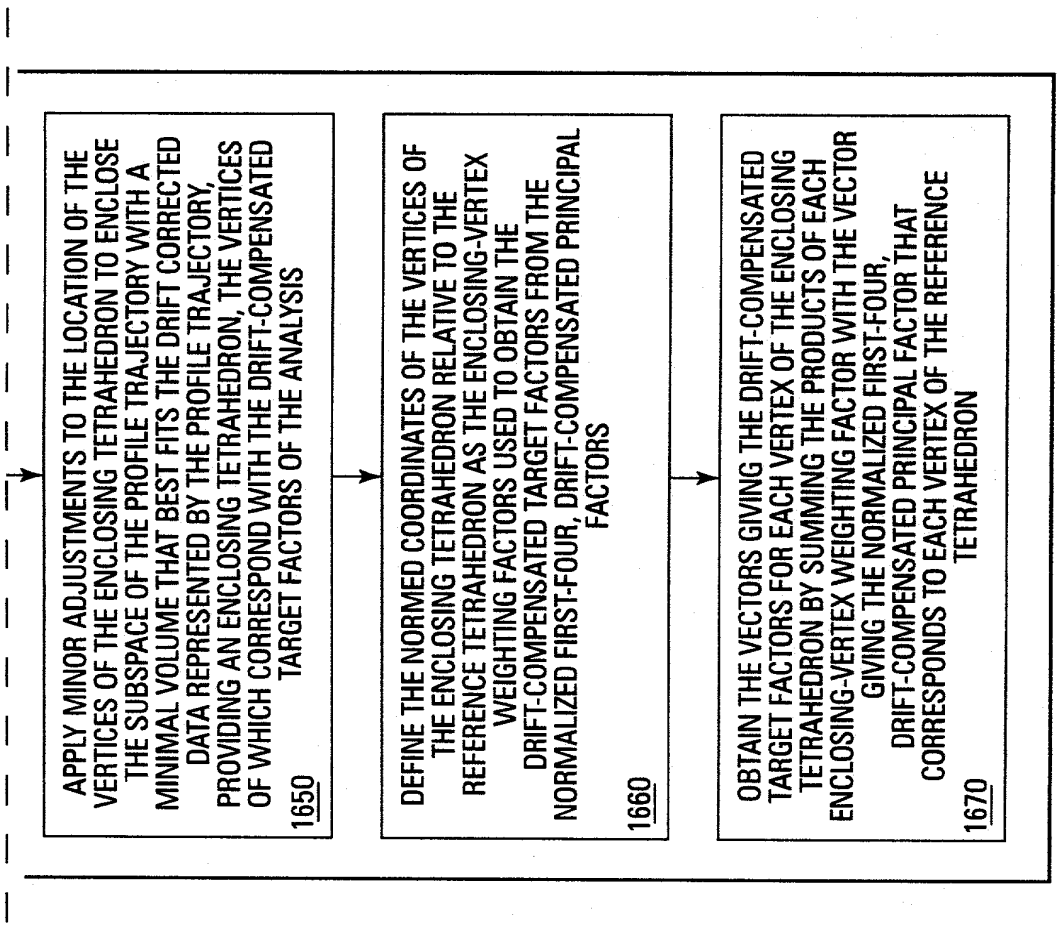

APPLY MINOR ADJUSTMENTS TO THE LOCATION OF THE VERTICES OF THE ENCLOSING TETRAHEDRON TO ENCLOSE THE SUBSPACE OF THE PROFILE TRAJECTORY WITH A MINIMAL VOLUME THAT BEST FITS THE DRIFT CORRECTED DATA REPRESENTED BY THE PROFILE TRAJECTORY, PROVIDING AN ENCLOSING TETRAHEDRON, THE VERTICES OF WHICH CORRESPOND WITH THE DRIFT-COMPENSATED TARGET FACTORS OF THE ANALYSIS
1650
DEFINE THE NORMED COORDINATES OF THE VERTICES OF THE ENCLOSING TETRAHEDRON RELATIVE TO THE REFERENCE TETRAHEDRON AS THE ENCLOSING-VERTEX WEIGHTING FACTORS USED TO OBTAIN THE DRIFT-COMPENSATED TARGET FACTORS FROM THE NORMALIZED FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS
1660
OBTAIN THE VECTORS GIVING THE DRIFT-COMPENSATED TARGET FACTORS FOR EACH VERTEX OF THE ENCLOSING TETRAHEDRON BY SUMMING THE PRODUCTS OF EACH ENCLOSING-VERTEX WEIGHTING FACTOR WITH THE VECTOR GIVING THE NORMALIZED FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTOR THAT CORRESPONDS TO EACH VERTEX OF THE REFERENCE TETRAHEDRON
1670

Fig. 16b

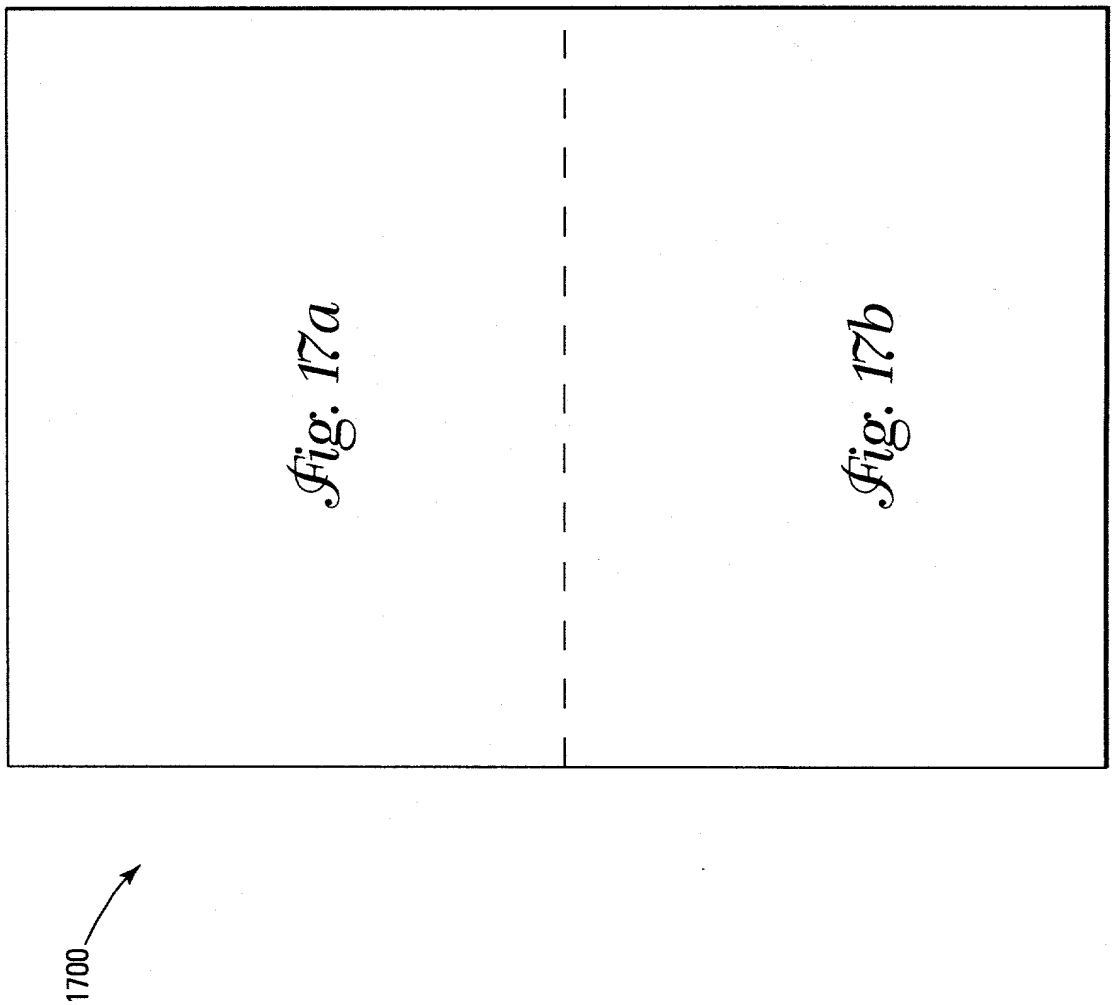


Fig. 17
Fig. 17a
Fig. 17b
1700

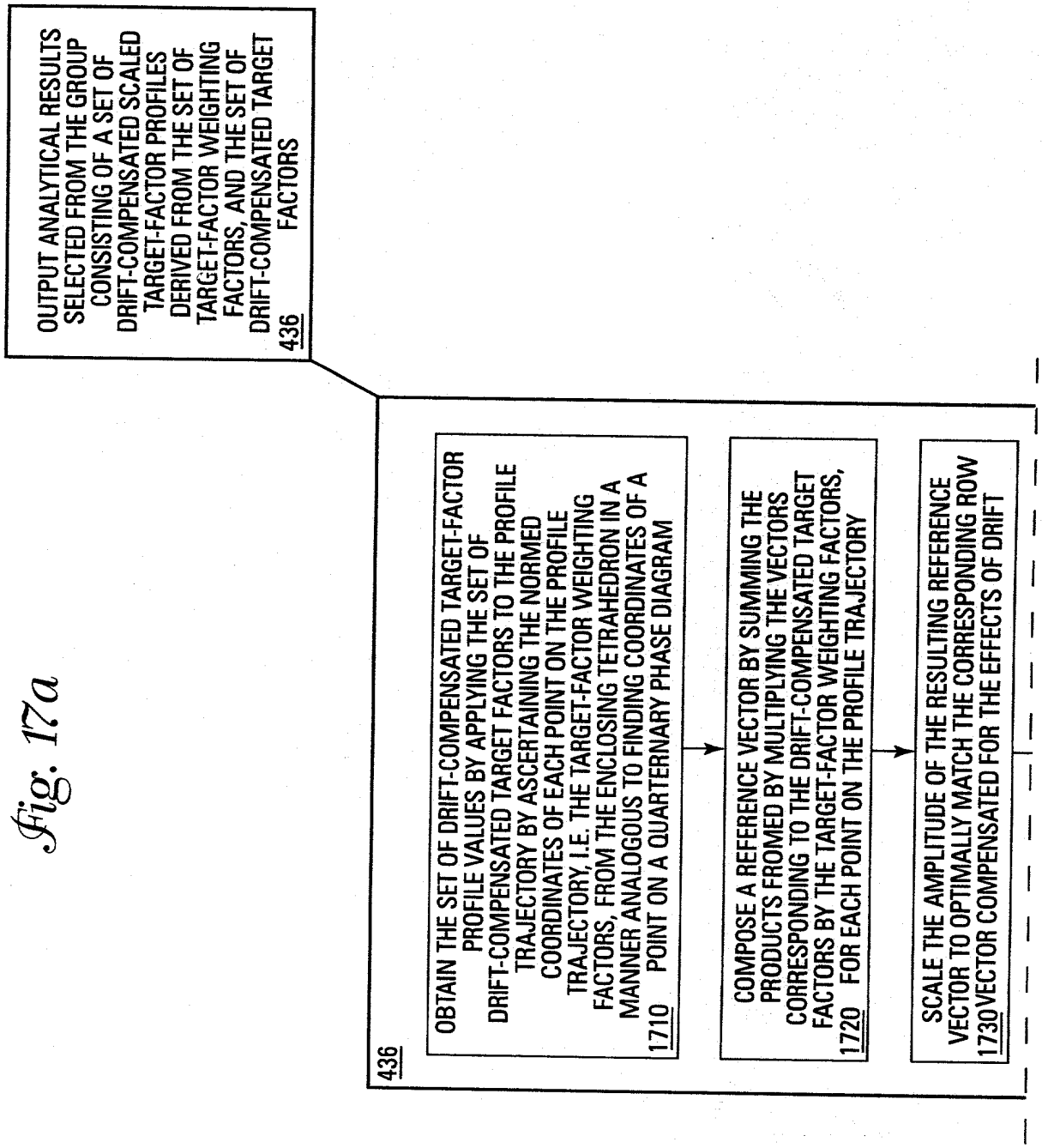

OUTPUT ANALYTICAL RESULTS SELECTED FROM THE GROUP CONSISTING OF A SET OF DRIFT-COMPENSATED SCALED TARGET-FACTOR PROFILES DERIVED FROM THE SET OF TARGET-FACTOR WEIGHTING FACTORS, AND THE SET OF DRIFT-COMPENSATED TARGET FACTORS
436
436
OBTAIN THE SET OF DRIFT-COMPENSATED TARGET-FACTOR PROFILE VALUES BY APPLYING THE SET OF DRIFT-COMPENSATED TARGET FACTORS TO THE PROFILE TRAJECTORY BY ASCERTAINING THE NORMED COORDINATES OF EACH POINT ON THE PROFILE TRAJECTORY, I.E. THE TARGET-FACTOR WEIGHTING FACTORS, FROM THE ENCLOSING TETRAHEDRON IN A MANNER ANALOGOUS TO FINDING COORDINATES OF A POINT ON A QUARTERNARY PHASE DIAGRAM
1710
COMPOSE A REFERENCE VECTOR BY SUMMING THE PRODUCTS FROMED BY MULTIPLYING THE VECTORS CORRESPONDING TO THE DRIFT-COMPENSATED TARGET FACTORS BY THE TARGET-FACTOR WEIGHTING FACTORS, FOR EACH POINT ON THE PROFILE TRAJECTORY
1720
SCALE THE AMPLITUDE OF THE RESULTING REFERENCE VECTOR TO OPTIMALLY MATCH THE CORRESPONDING ROW VECTOR COMPENSATED FOR THE EFFECTS OF DRIFT
1730

Fig. 17a

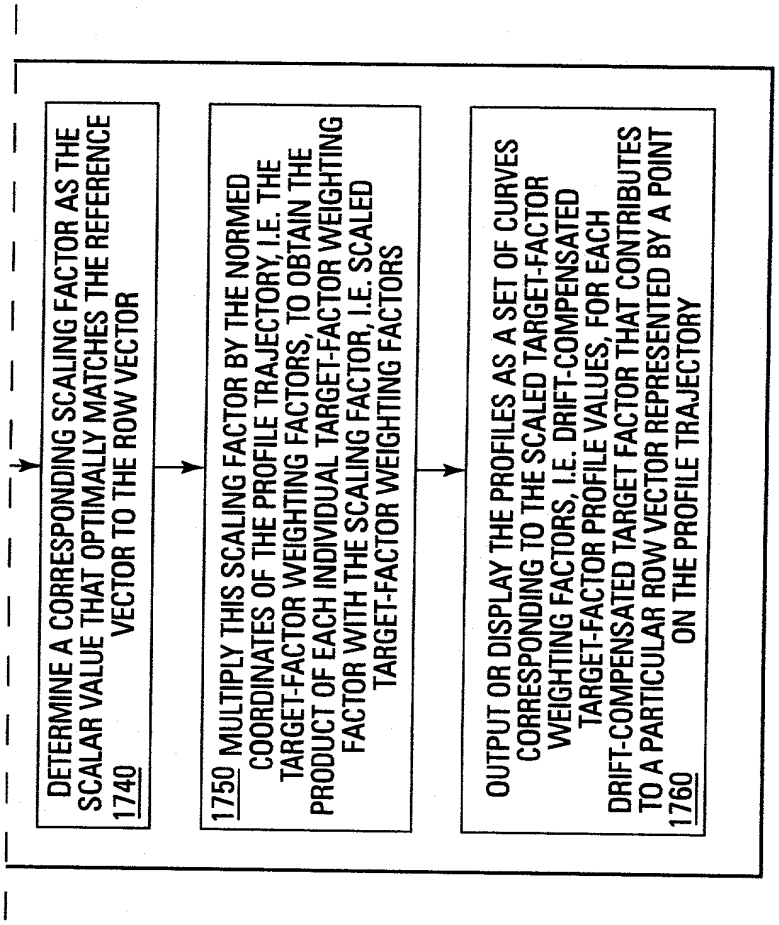

DETERMINE A CORRESPONDING SCALING FACTOR AS THE SCALAR VALUE THAT OPTIMALLY MATCHES THE REFERENCE VECTOR TO THE ROW VECTOR
1740
1750 MULTIPLY THIS SCALING FACTOR BY THE NORMED COORDINATES OF THE PROFILE TRAJECTORY, I.E. THE TARGET-FACTOR WEIGHTING FACTORS, TO OBTAIN THE PRODUCT OF EACH INDIVIDUAL TARGET-FACTOR WEIGHTING FACTOR WITH THE SCALING FACTOR, I.E. SCALED TARGET-FACTOR WEIGHTING FACTORS
OUTPUT OR DISPLAY THE PROFILES AS A SET OF CURVES CORRESPONDING TO THE SCALED TARGET-FACTOR WEIGHTING FACTORS, I.E. DRIFT-COMPENSATED TARGET-FACTOR PROFILE VALUES, FOR EACH DRIFT-COMPENSATED TARGET FACTOR THAT CONTRIBUTES TO A PARTICULAR ROW VECTOR REPRESENTED BY A POINT ON THE PROFILE TRAJECTORY
1760

Fig. 17b

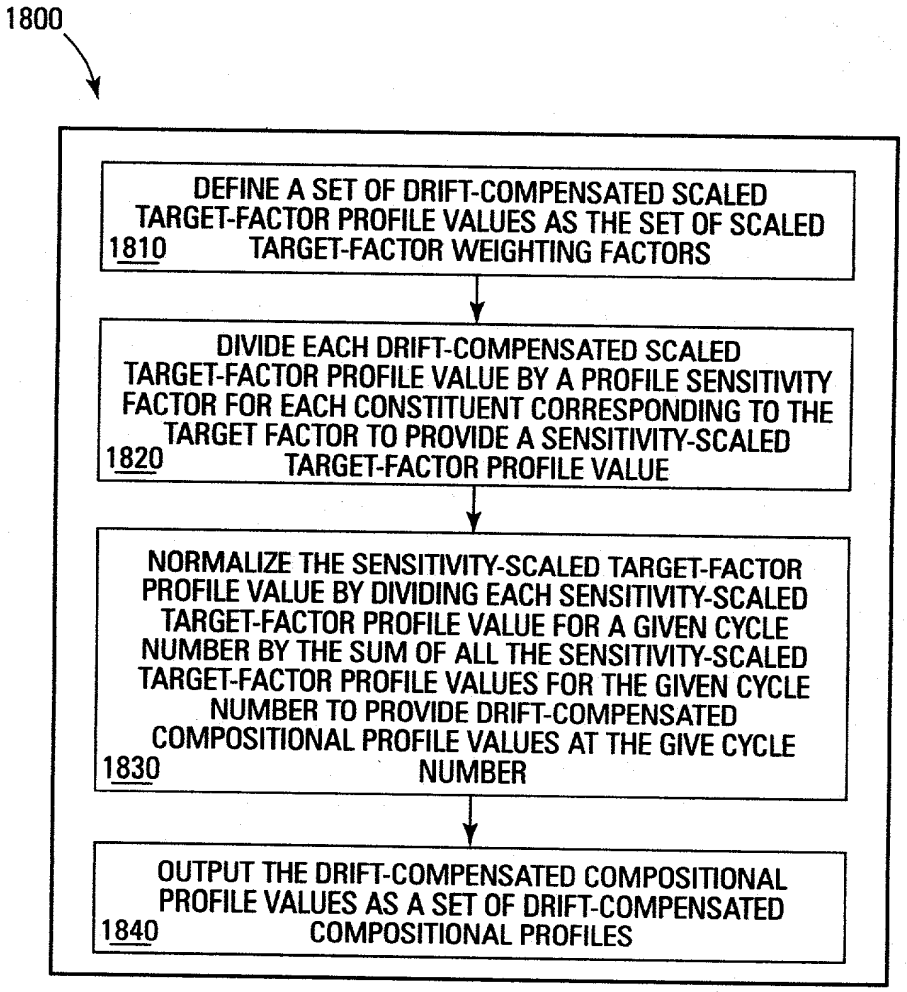

1800
DEFINE A SET OF DRIFT-COMPENSATED SCALED TARGET-FACTOR PROFILE VALUES AS THE SET OF SCALED TARGET-FACTOR WEIGHTING FACTORS
1810
DIVIDE EACH DRIFT-COMPENSATED SCALED TARGET-FACTOR PROFILE VALUE BY A PROFILE SENSITIVITY FACTOR FOR EACH CONSTITUENT CORRESPONDING TO THE TARGET FACTOR TO PROVIDE A SENSITIVITY-SCALED TARGET-FACTOR PROFILE VALUE
1820
NORMALIZE THE SENSITIVITY-SCALED TARGET-FACTOR PROFILE VALUE BY DIVIDING EACH SENSITIVITY-SCALED TARGET-FACTOR PROFILE VALUE FOR A GIVEN CYCLE NUMBER BY THE SUM OF ALL THE SENSITIVITY-SCALED TARGET-FACTOR PROFILE VALUES FOR THE GIVEN CYCLE NUMBER TO PROVIDE DRIFT-COMPENSATED COMPOSITIONAL PROFILE VALUES AT THE GIVE CYCLE NUMBER
1830
OUTPUT THE DRIFT-COMPENSATED COMPOSITIONAL PROFILE VALUES AS A SET OF DRIFT-COMPENSATED COMPOSITIONAL PROFILES
1840

Fig. 18

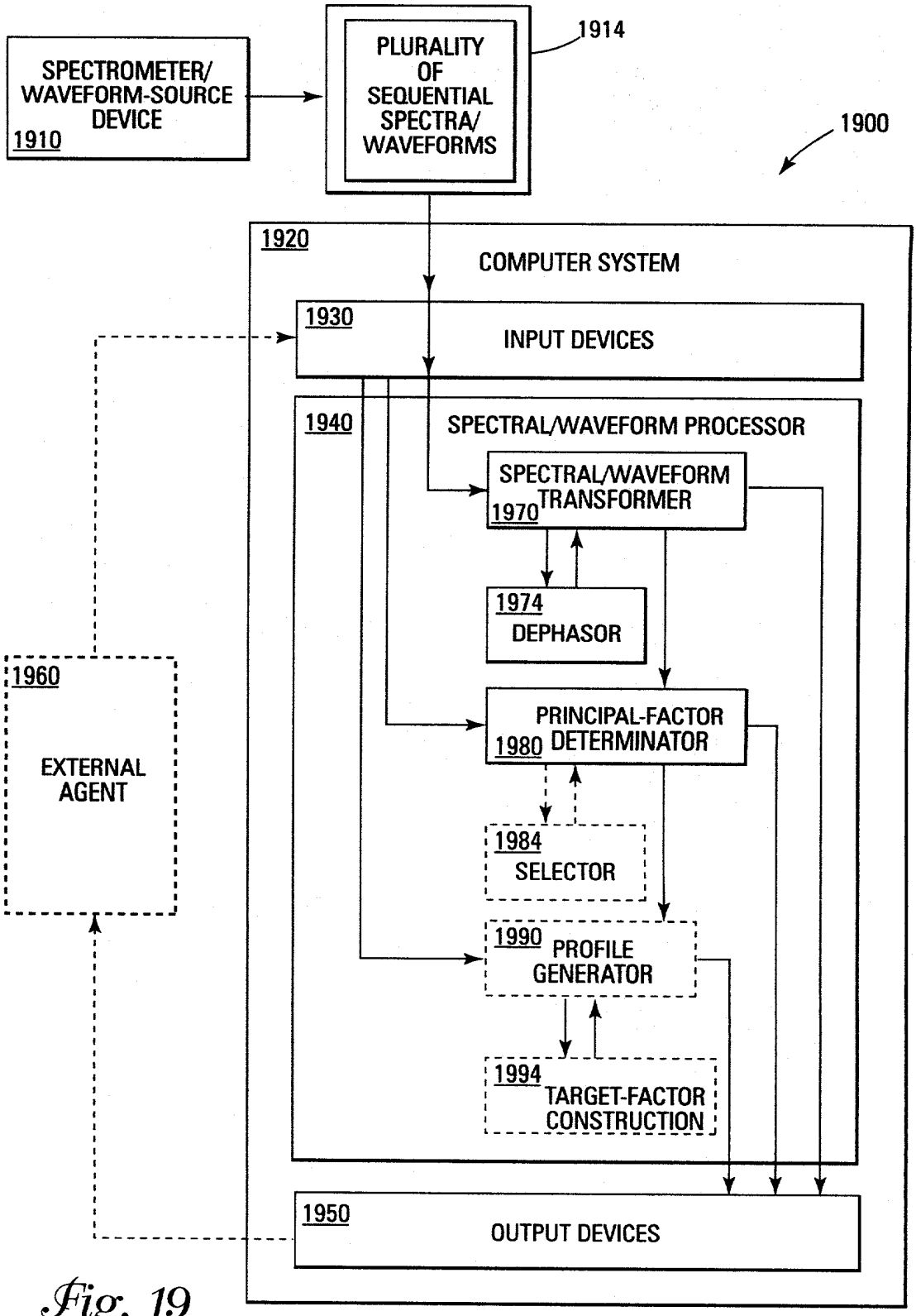

SPECTROMETER/ WAVEFORM-SOURCE DEVICE
1910
PLURALITY OF SEQUENTIAL SPECTRA/ WAVEFORMS
1914
1900
1920
COMPUTER SYSTEM
1930
INPUT DEVICES
1940
SPECTRAL/WAVEFORM PROCESSOR
SPECTRAL/WAVEFORM TRANSFORMER
1970
1974
DEPHASOR
PRINCIPAL-FACTOR DETERMINATOR
1980
1984
SELECTOR
1990
PROFILE GENERATOR
1994
TARGET-FACTOR CONSTRUCTION
1960
EXTERNAL AGENT
1950
OUTPUT DEVICES

Fig. 19

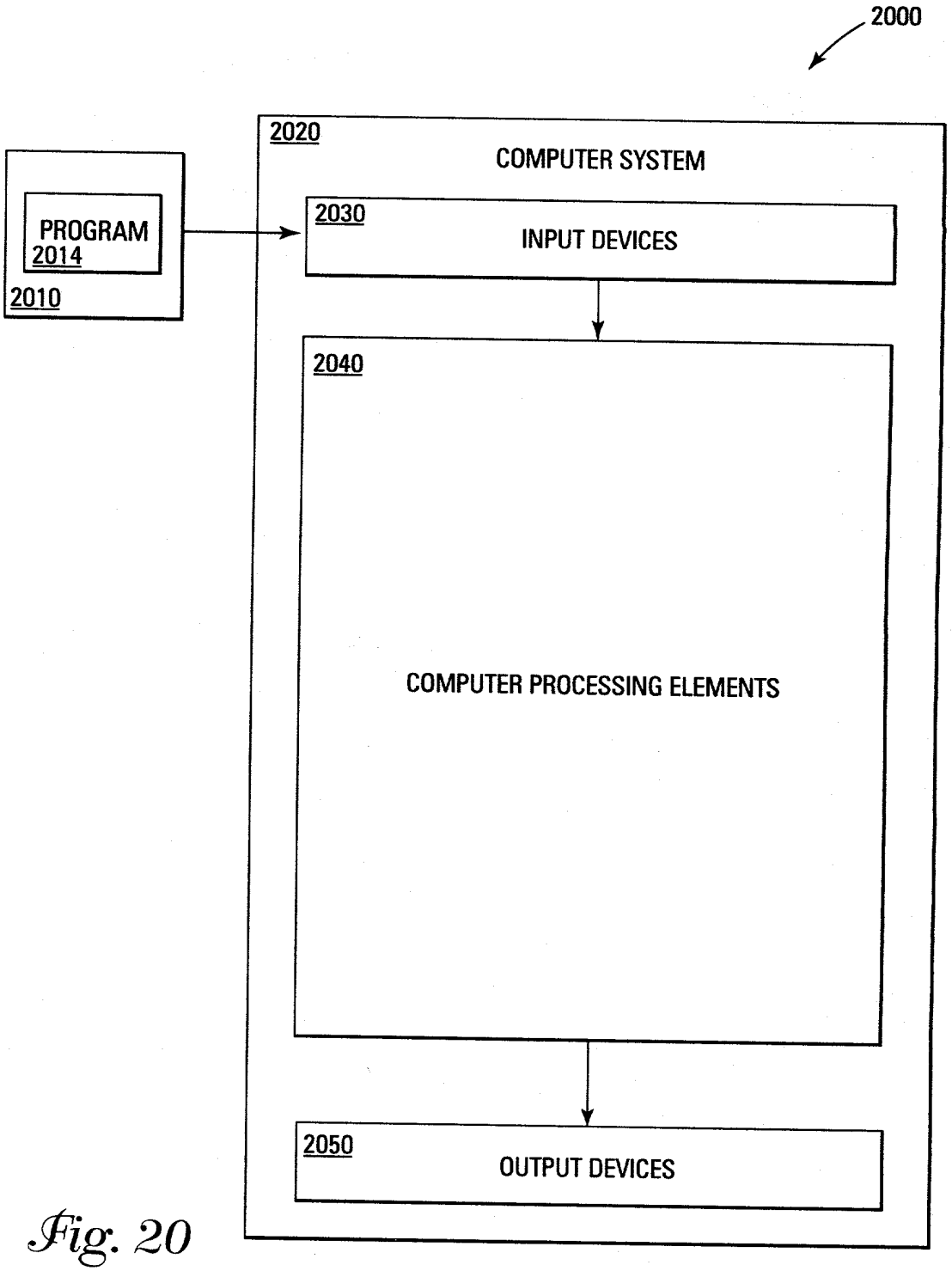

2000
2020
COMPUTER SYSTEM
PROGRAM
2014
2010
2030
INPUT DEVICES
2040
COMPUTER PROCESSING ELEMENTS
2050
OUTPUT DEVICES

Fig. 20